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AGRICULTURAL COMMODITY-BASED PLASTICS DEVELOPMENT ACT OF 1988

HEARING

BEFORE THE

COMMITTEE ON GOVERNMENTAL AFFAIRS UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

SECOND SESSION

ON

S. 2298

TO REQUIRE THE ADMINISTRATOR OF THE GENERAL SERVICES ADMINISTRATION TO ENCOURAGE THE DEVELOPMENT AND USE OF PLASTICS DERIVED FROM CERTAIN COMMODITIES, AND TO INCLUDE SUCH PRODUCTS IN THE GENERAL SERVICES ADMINISTRATION INVENTORY FOR SUPPLY TO FEDERAL AGENCIES, AND FOR OTHER PURPOSES

SEPTEMBER 20, 1988

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AGRICULTURAL COMMODITY-BASED PLASTICS DEVELOPMENT ACT OF 1988

TUESDAY, SEPTEMBER 20, 1988

U.S. SENATE,
COMMITTEE ON GOVERNMENTAL AFFAIRS,
Washington, DC.

The Committee met, pursuant to notice, at 9:25 a.m., in room SD-342, Dirksen Senate Office Building, Hon. John Glenn, Chairman of the Committee, presiding.

Present: Senators Glenn, Pryor, Levin, and Roth.

Staff present: Susan Carnohan, Kathy Connolly, Brian Dettelbach, Scott Faucher (Senator Glenn); Ed Gleiman (Senator Pryor); Elise Bean (Senator Levin); and Paul Kerkhoven (Senator Roth).

OPENING STATEMENT OF CHAIRMAN GLENN

Chairman GLENN. The hearings will be in order.

Good morning and welcome to this hearing before the Governmental Affairs Committee on S. 2298, the Agricultural Commodity-Based Plastics Development Act of 1988.

The legislation addresses two important issues facing Americans today, namely the return to health and prosperity for our Nation's agriculture and the very serious environmental problem that we face regarding the disposal of solid wastes.

This bill will promote the development of degradable plastics technology and private sector markets through the procurement of degradable plastic products by the General Services Administration. Special emphasis will be given to agricultural commodity-based products; $20 million will be provided for each of 3 years to pay for the differential between the cost of the degradable plastic products and conventional products.

It also directs the Secretary of Agriculture to report annually to Congress on the progress of research into the development of new non-food uses for agricultural commodities. And finally, an interagency working group will be established to coordinate the implementation of the Act and to annually report to Congress on its results.

The widespread introduction of this technology will benefit the American farmer since degradable plastics can be made by combining conventional plastic resins with starch made from corn and other agricultural commodities.

A wide variety of items can be produced using these techniques, including plastic packaging, plastic bags, agricultural mulch, milk jugs, dairy tubs, meat trays, diaper liners, fast food containers, industrial containers, pharmaceutical packaging, and a host of other things we haven't even dreamed up.

You see this container sitting up here this morning. This is not my water jug. I don't need that much water up here. What it is is a biodegradable jug made from this product that I am talking about. So it is here and now. It is not something that is out there still to be developed by R&D. It is here and now and we have sent one of these around to each Senate office with a little ribbon on it so my colleagues would know that this is for real. It is here and now and all we need is a push to get the thing going.

I have a plastic bag already in use. They make them in all different sizes and shapes, and they are biodegradable. It helps agriculture. It helps the municipal waste problem. The bag is also very strong. This is light weight, very easy to hold, but it is biodegradable.

That is what this hearing is all about, making that kind of product available for all those different things that we can make out of it, and there are literally thousands of uses for this if we just get it going and get it by the start up. That is what my bill tries to do.

Using durable injection molding techniques, such diverse products as children's toys, office supplies, automobile components are also feasible.

Now, if we go back into the research history of this country, one of the areas that has contributed most to our growth is agricultural production. And there are lots of places in the world which have land similar to ours, but we poured the money into basic research and we developed new soil stabilization techniques and new fertilizers that applied to certain products or certain crops.

We developed hybrids. We did all of these things. I use the example, sometimes, I think, when I was a kid back in Ohio, I think a good corn crop was considered to be something like 46 to 48 bushels per acre. Now, I think last year it ran 137—it is not going to be that this year because of the drought—but 137 bushels per acre.

We didn't do that because the farmers are going out and working 3½ times as hard. We did it because we learned those things that will produce. We did great research. That is on the production side. And we have been so successful with that that we have enormous surpluses. We store them in hopper cars and we put them in barges. We do everything because we don't even have the space to store the tremendous results of this productivity that we have.

We normally spend between $500 million and $600 million in research—most of it on the production side. For 1986, we spent $510 million through the Agricultural Research Service. Now how much do you suppose was spent over in the area of non-food uses?

Well, you would think that we would be spending $150 million maybe, $125 million, something like that. We spent $6 million. That is $6 million on non-food uses. We are still emphasizing the production side and I know we have some representatives of the Department of Agriculture here to explain. I just wish we could nudge you off dead center to spend more money over on the other side of this. We passed legislation back in 1985 that permits this kind of thing.

We have been unable to persuade you. This year, for the first time, we are now beginning to increase the non-food uses research. We want to continue expanding that because I think that we can do as good a job in research in the non-food uses of agricultural products as we have done over on that production side.

Agricultural commodity-based degradable plastics also address another serious problem which faces our Nation, that of solid waste management. More than one-half of the cities in the United States will exhaust their current landfill capacity by--when do you suppose—1990? That is just year after next, of course.

By the year 2000, plastics will comprise 10 percent of the solid wastes in our Nation's landfills. So the management of this growing volume of wastes is one of the most urgent fundamental environmental problems facing Federal, state and local officials.

Clearly there is no simple solution to the problem, but the answer lies in a number of initiatives, including recycling, new incineration technologies, and modifying our use and disposal of solid wastes. An important component of this will be the increased use of degradable plastics.

Today we are fortunate to have with us a wide variety of experts representing the full range of issues related to this subject. I will not go through all the names. I will go through them as we call them up for the panels here. We will save a little bit of time here this morning.

Our first witness is Senator Bond, Christopher Bond; and then Flora Milans, the Associate Director of Resources Communication of the Economic Development Division of GAO that has done the study for us that will be presented this morning. Then we will get into three panels. The Federal Government agencies, number 1; private and State interest groups, number 2; and private industry, number 3.

It is a long witness list. We have about 15 witnesses this morning so we are going to ask everyone to be brief. I just hate to do that but we had so many people who wanted to testify on this that we were inundated so we had to make some choices. We took as many as we possibly could but we ask that those comments do be kept brief this morning.

Kit Bond, are you here? Kit, welcome to our hearing this morning. We know of your interest in this. You come from a major agricultural State and we welcome your view of this legislation, suggestions, comments, whatever you want to say.

TESTIMONY OF HON. CHRISTOPHER BOND, U.S. SENATOR FROM THE STATE OF MISSOURI

Senator BOND. Thank you very much, Mr. Chairman. I thank you for the opportunity to appear before the Committee. Obviously, I share your enthusiasm for the exciting developments surrounding new non-food uses for agricultural commodities. And I welcome the opportunity to express my views on S. 2298, the Agricultural Commodity-Based Plastics Development Act of 1988.

Mr. Chairman, it seems that the general public is slowly becoming aware of these non-traditional uses for agricultural commodities. The current devastating drought has conveyed the plight of our farmers to millions of consumers. I truly believe that the majority of the public will give preference to agricultural products when they are comparable in quality and cost. Environmental benefits aside, the increased demands will strengthen commodity prices and allow our farmers to utilize better their productive capacity.

For example, the utilization of plastics derived from corn starch could expand the demand for corn by up to 500 million bushels per year. The environmental benefits which you have already mentioned associated with many of these new uses are equally impressive.

For example, with current plastics products singled out as a major contributor to our Nation's solid waste problem, many areas are considering legislation to limit or ban the use of traditional petroleum-based plastics. The development of biodegradable plastics derived from corn starch could address many of the problems caused by litter, marine pollution and landfills.

While no one can dispute the potential benefits of these new uses, the question becomes what is the Federal Government's role. I believe it is clear that the Federal Government does have a role to play and in my opinion the best role would be to make a long term commitment for the research and development of non-traditional uses for agricultural commodities.

Having said that, I would like to focus the remainder of my remarks on your bill, Mr. Chairman, S. 2298.

I must admit that I had mixed emotions when it was brought to my attention. On the one hand I was pleased to learn of your support for new uses, while on the other hand I was somewhat disappointed that your legislation beat me to the punch.

Chairman **Glenn**. Welcome aboard.

Senator **Bond**. Thank you. I am supportive of the general concepts and hope that we will continue to be allies in appropriating this developing technology.

While supportive of the bill's objectives, promoting these new non-food uses, I lean towards a slightly different approach. To date, sufficient research has not been performed to reassure potential users that degradable plastics actually do what they say they will. I note in the GAO report, which I gather you are going to have further testimony on later today, they say on page one, they note the limited amount of money that has been applied to degradable plastics R&D and they say that the Federal agencies supporting these activities are not among those that could undertake the formulation of standards.

Virtually no testing of degradable plastics has been done. The limited testing that is planned or is being conducted may hope to evaluate product performance but does not insure the establishment of standards for degradable plastics.

There seems to be a great concern about how these products will hold up under various conditions. Because there is a valid concern, I think our first priority and our top agenda item should be to conduct sufficient short term research to generate the necessary information.

Again, we come back to the need for additional research, as you have already pointed out, Mr. Chairman. Without adequate performance data, I am concerned that large field promotional efforts could cause us some short term problems.

For example, what if the Army decided to use some form of degradable plastics in field exercises and then discovered that the products fell apart in the rain? While this information would be useful, I think we would all rather learn this from a demonstration project than from an angry Army field officer. At this point, I think there is an important need to promote the need for additional funds for research and demonstration products.

I commend you, Mr. Chairman, for the legislative initiatives that you have introduced and I am very pleased to have supported your amendment to the agricultural appropriations bill.

I believe that once studies have been performed and the product's characteristics are determined, very little additional promotion will be necessary. In 10 years, degradable plastics may be the rule and not the exception.

On another issue, I am concerned that requiring GSA to pay the difference between conventional products and those derived from agricultural commodities could start a precedent that we may have to apply in other areas. If we are going to pay the difference for degradable plastics derived from corn starch, shouldn't we also consider doing the same thing for printing ink derived from soybean oil? That is another area where non-agricultural, non-food uses of agricultural products offers a tremendous opportunity to lessen the hazardous waste disposal problem of current petroleum-based inks.

Again, I think we ought to focus our efforts on funding research to make these products cost-competitive. I am going to be very interested to learn how corn starch plastics costs compare to conventional plastics. I assume that Mr. Wentworth from the National Corn Growers will be presenting these figures and I will bet they are much closer to being competitive than most people would realize.

Again, when we have the research and the demonstration available to give major users, such as fast food outlets and supermarkets, the information and the degree of biodegradability and the time required, I think we will find they are anxious to utilize these new products.

Again, the economies of scale which will come into play when a large chain or a large fast food franchise knows how biodegradable plastics will perform. I think we will see them purchasing on the scale necessary to make these degradable plastics at least cost competitive.

On another note, Mr. Chairman, I am excited to report that next month Missouri's capital city, Jefferson City, will be the first in the Nation to distribute degradable plastic trash bags. This 3-month trial will generate vital information regarding not only performance but consumer reaction. The initial trial is the result of a great deal of hard work, both from the National Corn Growers and the Missouri Corn Growers Association.

Finally, I have the pleasure of serving as co-chairman along with Senator Dixon of the newly formed Corn Caucus. We would invite Members to join this caucus. The objective is to provide Members a forum to develop, discuss and debate issues of interest to our Nation's corn producers. We have the initial meeting scheduled for October 5 and will focus on new uses and maybe we will be able to eat off of some biodegradable plastics plates.

Mr. Chairman, I appreciate your allowing me to appear before the Committee and I support your efforts with regard to S. 2298 and look forward to working with you in this very exciting and I think productive area.

Chairman **Glenn**. Good. Thank you, Kit. Thank you very much. Let's hear it for Jefferson City. I didn't know that that was going to occur but I am all for that.

Senator **Bond**. We are very proud of them.

Chairman **Glenn**. You made some good points. Let me just comment very briefly on them. I don't want to push this into something where it is going to be a failure. What we are doing now—we think this has come along far enough now, with demonstrated uses for shopping bags, things like that—is to move our research discoveries into practical everyday use.

We are getting beaten about the head and shoulders all the time by the Japanese and other people who come over here, and pick up an American idea. They run with it and all at once we are buying all of our TVs and VCRs and everything from some other country when they should be providing jobs here.

I wanted to form—and I got this through the Committee before we lost it later on in some of the consideration with the Commerce trade bill—I wanted to set up an ACTA. And ACTA was going to be an Advanced Civilian Technology Agency which was going to take some of these things and try and provide the spearhead for the movement, the drive to take them from the research lab into use in this country in a more rapid way than we do now. It was going to be a civilian counter part to DARPA, the Defense Advanced Research Projects Agency that has done such a remarkably tremendous job for the Defense Department through the years.

The Japanese are superb at this, moving a coalition of government and private investment people and research people and getting something going right now.

Now, with our antitrust laws and all here it is little more difficult for us you to do all of that, and I would not change those. But what the ACTA was going to do was sort of what we are doing with this legislation right now. We are saying, here is something that is here and now. It is ready. Not to be put in every use. I would not put pharmaceuticals in it yet. FDA has to approve that and I don't know what chemicals you put in this thing may bore a hole out through it. I don't know. So somebody has to look at that.

But we know right now that for shopping bags and things like this where GSA does buy jillions of these things per year, or similar items, that this technology is there now and what I am trying to do is provide a little bit of Government boost here to get the thing started. Then it will take off on its own. I don't want to be going down the road 20 years from now, as you say, still government subsidizing the program, automatically still pouring more money in every year. This is a boost to help get the thing started, get it over that initial cost hump and get the whole thing going.

So you very properly state, too, that we have not done all the testing and that is one of my concerns, that we get on with this. I would point out though in return, there are a lot of laws applied right now in that area that we did not have to repeat in this bill. FDA, for instance. What kind of foods can we put in these things without having some substance form that would be bad? I don't know. That is up to FDA to determine. We know there are enough uses right now for liquid storage and for shopping bags and things like that.

We can get going on this right now and I think it can be a big benefit to us. So I appreciate very much your comments this morning. You are right on target with them. I have some of the same concerns, but I think in the areas we know of that are absolutely safe, I think we are ready to move forward, give that little Government boost to get this thing going and use our agricultural products.

Senator **Bond**. Mr. Chairman, I think Senator Conrad will address—I hope he will address when he comes before you here—this Agricultural Research Commercialization Corporation proposal that has been introduced in the Senate. The House has passed a measure-or has on the suspension calendar—a measure which would include that as well another very exciting idea which I have some proprietary interest, a new crops measure which would permit a program crop producer to protect his crop base and plant some of the new industrial use products such as cranby, kenaf, guayule and other items.

But I think what you have defined that as your objective for ACTA may well be accomplished by Senator Conrad's ARCC, and he will, obviously, be able to speak to that in greater detail. I think we could all work hard to generate support to have the measure adopted on the Senate side.

Chairman **Glenn**. Good. I think I am all for your legislation. I think I am a co-sponsor of that.

Senator **Bond**. I think we all are.

Chairman **Glenn**. Good. Thank you very much. We appreciate it.

Senator **Bond**. Thank you, Mr. Chairman.

Chairman **Glenn**. Thank you much. I believe Senator Conrad had to leave. He had another commitment this morning. And I am sorry he had to leave. We will welcome his statement to be included in the record anyway and look forward to having the benefit of his observations on this.[1]

I have another statement to be entered in the record from Senator Allen Dixon, who is interested in this same thing and has his statement here.[2] We will enter that in the record also.

Our next witness this morning is Flora Milans, Associate Director, Resources, Community and Economic Development Division of the General Accounting Office.

Ms. Milans, we welcome your testimony this morning, and if you would introduce your associate there, we did not have a name.

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[1] See p. 215.

[2] See p. 218.

TESTIMONY OF FLORA H. MILANS, ASSOCIATE DIRECTOR, RESOURCES, COMMUNITY AND ECONOMIC DEVELOPMENT DIVISION, GENERAL ACCOUNTING OFFICE,[1] ACCOMPANIED BY LOWELL MININGER, GROUP DIRECTOR

Ms. MILANS. I certainly will. Thank you. I have with me here today Mr. Lowell Mininger, who is group director responsible for GAO's research and innovation work.

Chairman GLENN. Good.

Ms. MILANS. Mr. Chairman, we are pleased to be here to discuss our report on degradable plastics which was requested by this Committee and is being issued today.[2] Overall, we found that only limited Federal and private sector efforts are being made to develop standards for degradable plastics. There is a growing interest in commercializing degradable plastics. With this has come a general recognition in both Government and industry that standards for degradable plastics need to be developed.

Such standards would include uniform definitions and methods of testing to evaluate product performance. They would help assure consumers of a satisfactory product and help manufacturers comply with legislation mandating their use. We also found that Federal agencies' support of degradable plastics research and development has been limited. Federal expenditures total $1.7 million for 12 projects in fiscal year 1988.

Chairman GLENN. Repeat that. That is worth repeating.

Ms. MILANS. $1.7 million in fiscal year 1988. And these projects emphasize the development of new degradable plastics materials rather than standards development.

Skipping the background, I would like to discuss the need for standards. Definitions of such basic terms as photo- and biodegradation have not yet been agreed upon, nor have uniform methods of testing been developed. In developing standards, two important technical uncertainties associated with degradable plastics remain to be addressed: first, the rate of degradation and second, the safety of the end products.

Issues relating to the rate of degradation include the possibility that degradation may occur before the product has served its purpose or that it may occur too slowly to provide an effective solution to environmental problems.

Safety related issues include the potential toxicity of chemical leaching from degradable plastics and the size of the plastic fragments resulting from degradation which may pose a threat to wildlife.

Standards, according to various officials in the Federal and private sectors, are needed as a basis for effective legislation. Officials are concerned that the current lack of standards may lead to unenforceable or confusing laws. Current legislation in 16 States requiring the use of degradable plastics for 6-pack holders tends to corroborate this concern. Laws in nine of these States provide no definition of degradability; 10 States specify no timeframe for degradability, and 11 States provide no requirements regarding the safety of the end products.

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[1] See p. 66 for Ms. Milan's prepared statement.

[2] See p. 220.

Definitions, when provided, refer mainly to general processes. Timeframes, when specified, vary between 120 days in Florida and 5 years in Minnesota.

Of the five States with end-product safety requirements, only two States require that both the particle size and chemical composition of degradable plastics fragments be established as safe, but neither provide criteria for judging safety.

Now I would like to turn to what the Federal Government is doing. There are three primary Government agencies with the capability to test and develop standards for new materials and products; the Environmental Protection Agency, the National Institute of Standards and Technology, formerly called the National Bureau of Standards, and the Food and Drug Administration.

EPA's Office of Research and Development contains at least four laboratories capable of conducting needed tests but none is currently under way. EPA is currently conducting a study on methods to reduce plastic pollution as mandated by the Marine Plastics Pollution Research and Control Act of 1987. To respond to the Act, EPA plans to review technical literature and monitor certain private sector efforts to develop definitions and methods of testing for degradable plastics.

EPA officials said that although the laboratories possess the capability, no tests of degradable plastics are currently underway because of other research and testing priorities. As a result, they expect that any future efforts involving degradable plastics would probably be limited.

NIST is planning to undertake one very small scale project to bury starch-based degradable plastics in soil and expose them to strains of micro-organisms. According to a senior official, one of three developments would have to occur for NIST to expand its testing; first, the designation of a lead agency for degradable plastics, and that agency providing funding to NIST; second, an internal budget initiative; or third, a Congressional mandate.

Turning to FDA, the Food and Drug Administration has not approved any materials that are intended to increase the degradability of plastic food packaging. However, the Agency has recently been contacted by and is working with companies that are interested in food packaging uses of degradable plastics. A senior agency official told us that FDA's assessment of food safety includes concerns about the shelf life of degradable packaging and potential food contamination. FDA places the burden of proof for the safety and functionality of a new product, as well as the analysis of environmental impact, on the manufacturer.

Now I would like to discuss what the private sector is doing to develop standards, primarily through the American Society for Testing and Materials, ASTM.

ASTM describes itself as the world's largest source of voluntary consensus standards. One of its technical committees, known as the D–20 Committee on the Permanent Properties of Plastics, is chiefly responsible for ASTM's recent efforts to develop standards. The subject was introduced for the first time at a committee meeting in March 1988. Two officials were appointed at that meeting to work on definition standards and methods of testing. The official responsible for definitions is focusing on five principal terms, including biodegradability and photodegradability.

The official concerned with standards and methods of testing sent a letter to about 40 companies and individuals inquiring whether they have or are aware of any standards relating to degradable plastics. He found no relevant standards but wanted to establish this fact as a starting point for further ASTM efforts.

In summary, officials in the private and Federal sectors recognize the need for degradable plastics standards but relatively little effort to achieve this objective soon is underway. EPA, NIST, and FDA report few or no activities in this regard. ASTM's efforts are just getting underway and their outcome is uncertain.

Now, skipping the details of the federally funded R&D which is contained in our report issued today, I would like to present a matter for consideration by the Congress. If the Congress wishes to promote degradable plastics, it may want to consider the following approach. Select an agency or agencies which, in cooperation with the private sector, would undertake the development of standards, including uniform definitions and methods of testing. EPA and NIST would be appropriate agencies for such activity because of their extensive experience in testing for environmental effects and product performance.

This concludes my statement, Mr. Chairman. I would be happy to answer any questions that you might have.

Chairman GLENN. Good. Thank you. Who was that you suggested now to do the testing?

Ms. MILANS. EPA and/or NIST.

Chairman GLENN. Okay. I think it is probably a very good suggestion, because as Senator Bond said, and as you point out, we do need a lot of testing. But it was my feeling, and I think those of the people that have looked at this, that we have enough good uses of the material right now that can be made, that we can go ahead with that right now and get going and that is what this bill really is all about.

Your concern about the testing, I share your concerns on that. We don't want to see this product or derivative products, broadened out into areas that would cause a lot of problems, whether it is food or—you know, once we get this into a landfill, what will happen? Is there methane gas? Does that become a problem?

Are there any chemicals developed out of any of these types of things? Are there any chemicals developed that would be a hazard in ground water? The aquifer level? To flora or fauna, whatever they might be, wildlife that might eat the material or be tempted to eat the material.

All sorts of testing is needed so I agree with that completely. But I am also concerned that we get going and not let this very promising new area just go to somebody else. I want to see us get moving with it and use our agricultural products in this area.

You suggested the one-agency approach. Is there any other process that might be used to develop and issue standards? Under existing law, for instance, FDA has a role to play in this, obviously.

Did you look at the laws that might apply on this that are already there? Or do you feel we need new legislation to set up the testing and standards approach?

Ms. MILANS. Well, we did not look at legislation in depth. I believe FDA does have the authority to allow food packaging in plastics to occur, to issue those standards. It is not a question of authority, to my knowledge, in that situation. I think what we are trying to promote is within existing authorities there are some agencies such as EPA and NIST, and we would not preclude FDA's current authority on food packaging standards. But you can use the existing system so long as the lead agency is designated.

Chairman GLENN. In your look at this so far and the people you talked to on this, do you feel it is safe to move ahead though now with the uses of things like we talked about here, the plastic bottles for liquid storage of non-food storage and plastic bags? Of course, some of them are being used now. Is that a safe procedure now?

Ms. MILANS. Well, we did not independently evaluate the technical uncertainties and the safety. I believe the Office of Technology Assessment is doing that right now and should be available to you. Our thought is that if you want to promote this, this will provide consumers a greater sense of what the product will do and it will allow the manufacturers a greater sense that they are complying with the legislation.

Chairman GLENN. GAO, excellent, thank you very much. As always, GAO comes through when we asked them and we appreciate your help in this area. I am sure we will be looking into this more as time goes on so we will look to you for some expertise and help in this area.

Thank you very much.

Do you have any further comment? You have been notably silent here.

Mr. MININGER. No. I think there certainly are mechanisms available. I think even NIST, formerly Bureau of Standards, has a mandate to work with industry on this kind of thing. And EPA does that routinely in other areas and should have no difficulty, given a mandate, to work with industry in pursuing this opportunity.

Chairman GLENN. Well, as I said before, I just think this is ready to go for limited uses. We are not trying to push it into areas that you very properly say we need more testing on standards developed for, and I agree with that 100 percent. Like Kit Bond said a little while ago, you know, we cannot have something developed that out in the field with the Army you find out it rains on it and it comes apart or whatever. And we are not trying to push it into uses for which it is not qualified yet.

But I am getting tired of being beaten in the international market by every person that comes along and picks up an American idea and runs with it and we wind up buying it from them. And this is one that appeared to me to be ready to go and if we can give a little nudge to help GSA get started, that is what this is all about. Meanwhile, let's get going with working out the standards of testing that you properly point out are needed and let's move on. That is the purpose of this.

Thank you very much. We appreciate it.

Ms. **Milans**. Thank you.

Chairman **Glenn**. Senator David Pryor, do you have any comments you want to make?

Senator **Pryor**. Mr. Chairman, I am going to wait until a little bit later.

Chairman **Glenn**. Good.

Senator **Pryor**. We appreciate you having this hearing.

Chairman **Glenn**. Good. Thank you.

Okay, our first panel is Federal Government agencies. We have Lew DeProspero, Assistant Commissioner, GSA; we have Winston Porter, Assistant Administrator for Solid Waste and Emergency Response, Environmental Protection Agency, accompanied by Sylvia Lowrance, Director, Office of Solid Waste of EPA; Robert Long, who is Deputy Assistant Secretary for Science and Education of the USDA.

I mentioned starting out, ladies and gentlemen, that we had a problem with the number of witnesses this morning. I hate to put the light on on you there, so I will not do that, but we would really appreciate it if each one of you could keep your comments to 5 minutes. I hate to do that, but we had so many people who wanted to testify on this that it was hard to limit things, and if we are going to get through by before this afternoon, we are going to have to all cooperate here.

I just really deplore bringing people in from all over the country and I know they have worked on their statements and want to give them, and that is only fair, and then to bring them in and say that you just have 5 minutes is hardly fair, but that is what we are going to have to do this morning.

All the statements, whatever length, will be included in the record. If you can summarize them in 5 minutes we would certainly appreciate it. We will not use the lights on you this morning, but please keep it within that if you possibly can.

Thank you. Mr. Deprospero, will you lead off for us this morning.

TESTIMONY OF JAMES L. DePROSPERO, ASSISTANT COMMISSIONER, GENERAL SERVICES ADMINISTRATION,[1] ACCOMPANIED BY WILLIAM GORMLEY, DEPUTY

Mr. **DeProspero**. Mr. Chairman, I am James L. Deprospero, Assistant Commissioner for Commodity Management, Federal Supply Service, GSA. Mr. John Alderson has asked that I represent him before you today to provide GSA's views on S. 2298, a bill requiring that the Administrator of GSA identify products in the GSA purchasing catalog that can be made from degradable plastic technology and that are environmentally safe, with particular emphasis on agricultural commodity-based products and make these products available to the Federal Government through the competitive bidding process.

I am accompanied today by Bill Gormley on my right, who is my deputy, and in the interest of trying to save time, you do have my testimony so I plan to hit some of the highlights of this testimony.

Chairman **Glenn**. Good, we appreciate that.

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[1] See p. 77 for Mr. DeProspero's prepared statement.

Mr. DEPROSPERO. GSA is certainly sympathetic to the intent of S. 2298. We believe, however, that a procurement program which promotes the use of degradable plastic products can be implemented satisfactorily under existing statutory authority. However, there are several key questions that must be answered before GSA can undertake such a program.

Among these concerns are the extent to which industry can respond to such a program and produce the products necessary to meet the Government's requirements; the time frame necessary for degradable plastics to become competitive with comparable conventional plastic products; whether a preference buying program would be sufficient incentive for commercial marketing; and whether such a program would be practical, feasible or desirable; whether the bill conforms fully with Federal Acquisition Regulations, including the Competition in Contracting Act, CICA, particularly with nondegradable plastic products being precluded from competition; whether the human and monetary resources necessary for implementing the large scale requirement of the bill are readily available within the Federal Government; and whether the ability of small businesses to compete in GSA's procurement would be affected since such businesses might be unable to obtain finances necessary to accomplish the product changes envisioned by this bill.

In addition, the preferential treatment for such products could cause them to obtain fewer awards under GSA procurements.

You also asked that we comment specifically on the feasibility of a preferential procurement program for degradable plastic products as well as give an economic assessment of such a program.

Regarding feasibility, we believe that a preferential program could be developed but we do not yet know the extent to which the research and development program has progressed, nor do we know the state of the industry regarding degradable plastics.

An economic assessment of this kind of program is equally as difficult to address. Although we have read that in some cases the basic degradable material used to produce products is 15 to 25 percent more costly than regular plastic material, we have no information on how this translates to the cost of the end item. Will new equipment be required? Will it be specialized for degradable plastics? Do any companies have production capabilities? And is there competition? These are key factors.

You further requested certain data on products in GSA's supply system that would be made of agricultural-based plastics. Using the categories of products listed in the proposed bill we have developed a list and have submitted them to the Committee. We are providing this information with certain caveats that should be noted.

We do not claim that any of the items will perform satisfactorily when made from agriculture-based degradable plastics. That is something we do not know at this time. The listing demonstrates the wide variety of types, styles and sizes of products that we find in just one category of items. This points out the importance of the interagency working group to the ultimate success of a procurement program. The large number of items in the few catagories shown emphasizes the need to address this important program with a procurement so as not to overwhelm the industry or our procurement offices.

Finally, the cushioning material is not in the supply catalogue. However, while you will not be able to readily identify each item, a number of different items have been provided.

Mr. Chairman, this concludes my prepared statement on S. 2298. GSA appreciates you providing us the opportunity to present our views on the bill and we have submitted a statement for the record.

Mr. Gormley and I will be pleased to respond to any questions which the Committee members may have on this subject.

Chairman GLENN. Thank you very much. I would rather run through all the witnesses first and then we can question maybe and have some play back and forth here as you have different opinions of each other's comments also.

Our next witness is Dr. J. Winston Porter, Assistant Administrator for Solid Waste and Emergency Response, EPA, accompanied by Sylvia Lowrance, Director of the Office of Solid Waste.

Dr. Porter, go ahead.

TESTIMONY OF J. WINSTON PORTER, PH.D., ASSISTANT ADMINISTRATOR FOR SOLID WASTE AND EMERGENCY RESPONSE, ENVIRONMENTAL PROTECTION AGENCY, ACCOMPANIED BY SYLVIA LOWRANCE, DIRECTOR, OFFICE OF SOLID WASTE

Dr. PORTER. Thank you, Mr. Chairman. It is a pleasure to be here. I, again, will submit my testimony for the record and briefly summarize it.[1]

Today I will quickly cover the overall solid waste situation in the country and then talk specifically about plastics and your bill.

Solid waste disposal is perhaps the most urgent problem in our nation. I think that is a fairly strong but a true statement. From my perspective—I am managing the Superfund and all of the solid waste programs—it is clear that we are in a near crisis situation on solid waste. We are running out of landfills, as you suggest, and we are having many other difficulties.

I will provide just a few numbers. We have 160 million tons a year of solid waste now. We expect an increase to about 190 million by the year 2000.

The solid waste stream is roughly 40 or 41 percent paper, about 18 percent yard waste, 9 percent metals of various types, 8 percent glass, 8 percent food waste, about 8 percent rubber and leather goods and about 7 percent plastics, leaving about 1 percent for a lot of other small items. So it is a very mixed stream and the 2 largest components are actually paper and yard waste.

Chairman GLENN. I said I was not going to get to questions, but let me ask you, have you broken that down into percentage of this that is degradable and nondegradable? Because you talked about glass and things like that. If you go back to metals, ferrous metals will rust, things like that erode over time, but what percent is degradable and nondegradable.

Dr. PORTER. Well, I would say it is roughly two-thirds.

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[1] See p. 97.

Chairman **Glenn**. Two-thirds what? Degradable.

Dr. **Porter**. Two-thirds of the total waste stream might be degradable. Paper is certainly degradable, although it takes quite some time to degrade paper. And yard wastes are certainly degradable. But you are right, some of the others are not.

The ways we handle this waste stream, Mr. Chairman, are through various methods; about 80 percent of it is landfilled right now. That is, it goes to landfills, the ones you mentioned that are filling up rapidly. About 10 percent is recycled and about 10 percent is incinerated. That is our current situation.

The situation is getting very serious, as I have indicated, due first to filling up the landfills. But compounding that is the difficulty of siting new facilities. It is inordinately difficult to get people to accept new landfills or new incinerators in their counties or neighborhoods. The minimal recycling I mentioned, totalling about 10 percent, of which plastic is only about 1 percent; about 1 percent of plastic is recycled.

And finally, a manifestation of the problem is the inappropriate disposal we are seeing of things like medical wastes. So the problem is serious and unfortunately it may get more serious before it gets better. What we are promoting at EPA is what we call an integrated waste management approach where we think we are going to get all of our tools; source reduction, biodegradation, recycling, incineration, and landfilling, in roughly that order.

We are trying to make landfilling and incineration safer. We have recently promoted new regulations for landfilling and are developing additional regulations on incineration. We have also set a 25 percent recycling goal for the country. I have discussed a goal of 25 percent recycling for the whole solid waste stream in the next 4 years. I am happy to report that many States have picked up on that. Some are ahead of us, some are a little behind us, but a lot of them have picked up 25 or 30 percent of the target for the next 4 or 5 years.

We have a number of initiatives which I will not get into, also. This Thursday, we are having a press conference to kick off a major EPA initiative on solid wastes, plastics will be part of that; other issues will also be discussed.

Let me return now to plastics, specifically. Plastics are an important issue. Even though they are only 7 percent or so of the waste stream, they are a growing percentage.

As I believe you pointed out, Mr. Chairman, and others have pointed out, they are going to grow to maybe 10 percent in a few years. A large percent of that is in packaging materials. It is also important to note that plastics take many forms. We have polyethylene, polystyrene, polypropylene, polyvinyl chlorides, and on and on and on, various kinds of plastics, all of which are a little different.

They are also used in food and medicine and for other uses, including the trash bags you showed. All of these present a slightly different situation.

The problem with plastics is really three-fold in the waste stream. One is, they take up space; not a huge amount of space because they are small relative to some other things. But they do take up valuable space in our landfills. They also cause damage to wildlife, and, third, we have an esthetics problem with inappropriate disposal along road sides and so forth. We have a several faceted problem on plastics.

There are at least three things we can do with plastics, including landfilling. We can recycle them. There is absolutely no reason we cannot do much more than the 1 percent recycling being done now. We can incinerate them. They are a very high BTU source. Some plastics have more BTUs per pound than coal. Finally, we can do degradation, either photodegradation or biodegradation, and we are all for that.

The biodegradation is of strong interest to us, but we have some concerns, as mentioned earlier. One concern is the products of degradation. This is of more interest, I think, potentially, in food uses than it is, for example, in garbage bag uses. We have some concerns about what the products of degradation are as things degrade. Plastic doesn't just go to air, it goes to something else when it degrades, and in some cases the degradation is not degradation as such; it is simply falling apart into smaller particles.

Mr. Chairman, we are doing an important study right now under Section 2202 of the Marine Plastic Pollution Research and Control Act of 1987. This study will be finished by this coming summer. What we are doing is looking at improper disposal practices of plastics. We are evaluating substitute materials, including degradable plastics and we are evaluating the impact of plastics on the solid waste stream and methods to reduce their impact.

I might close by saying, Mr. Chairman, that we support the intent of your bill and want to work with you on it. We have some questions on the specifics. I think the degradables, in terms of what they really degrade to, is probably our key interest.

In addition, we want to be sure that we take into account the total waste management system as we work forward on bills like this.

We would be happy to work with you, GSA, the Department of Agriculture, and others. We applaud your bringing forth this bill. We think it has some relevance.

As I said, I think solid waste is perhaps our most pressing issue and we will be happy to work with you on it.

Thank you.

Chairman GLENN. Thank you, Dr. Porter.

Mr. Long is Deputy Assistant Secretary for Science and Education of the Department of Agriculture.

Mr. Long, welcome.

TESTIMONY OF ROBERT W. LONG, DEPUTY ASSISTANT SECRETARY FOR SCIENCE AND EDUCATION, U.S. DEPARTMENT OF AGRICULTURE, ACCOMPANIED BY WILLIAM M. DOANE, PH.D. AGRICULTURAL RESEARCH SERVICE

Mr. LONG. Thank you, Mr. Chairman. I also appreciate the opportunity to appear before you and members of the Committee to discuss the activities of the Department of Agriculture as they relate to S. 2298.

Chairman GLENN. Just for the record, would you introduce your associate here? We did not have his name.

Mr. LONG. I was going to do that in just a moment.

Chairman GLENN. Thank you.

Mr. LONG. My full statement, like the others, is submitted for the record.[1] I will try to be brief with what I have before me. Joining me for this testimony is Dr. William Doane, Agricultural Research Service. He is the research leader of the Plant Polymer Laboratory, Peoria, Illinois.

Chairman GLENN. Good.

Mr. LONG. You have expressed your interest in the research and development programs of USDA regarding new non-food uses of agricultural commodities. The total amount spent on this research, the types of products ready for commercialization and their estimated costs, and finally, the economic projections of the amount of corn and other commodities that could be utilized by these products.

I will respond to these questions shortly. At this point I will be quoting, I think, interestingly, from the past.

> One way to expand the farmer's market is to develop industrial uses for farm products. The terms industrial market and industrial uses, however, have come in recent years to have a narrower special meaning. Traditionally the farmer has produced raw materials for food, fiber and shelter. This is still his main business, but our highly complex civilization also provides a rapidly expanding market for other goods in a bewildering variety, ranging from cosmetics to airplanes. Human wants for these things have no discernible limit. To what extent does the farmer supply the raw materials for the industries based on these new wants? And what are the possibilities of expanding this portion of the market?

Mr. Chairman, what I have just quoted is interesting from the standpoint that it came from the 1940 Year Book of Agriculture. We do seem to turn on these issues and come back to them.

It was entitled at that point, "Farmers in a Changing World." Forty-eight years later the world of the farmer is, of course, still changing.

Some of the earlier new technologies are causing present day concerns. We live in a society where disposable plastic items are commonplace. Yet the problem we have is one of these disposable items ending up in ever-growing landfills where they remain virtually forever or they end up on the roadsides and in streams or in perpetuity in the oceans.

Today as a result of the extensive research both in the public and private sectors, we do have the ability to produce biodegradable plastic products. The Agricultural Research Service is rightly proud of the role which it has played in developing these products. ARS's Northern Regional Research Center in Peoria has conducted basic research over the last several years to develop technology for the incorporation of starch from corn or wheat into plastic film.

In addition to providing new markets for starch, the objective was to provide an agricultural mulch film that would degrade sufficiently during crop growing season so the removal of the film before planting next year's crop would be unnecessary. The research element that has been the most challenging is to provide polyethylene films containing high levels of starch, since polyethylene and starch are totally incompatible.

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[1] See p. 106.

Our research to date has been partially successful in that a technology has been developed to provide one type of starch-based plastic film. This technology has been patented and an exclusive license has been granted. The licensee will market their first commercial starched-based plastic this year.

ARS is continuing its research on starched-based plastics to meet three objectives. The first is the challenge to develop the technology for providing starch plastic films containing high levels of starch in properties acceptable for the broad market usage. The second objective is to develop technology leading to starch plastic compositions acceptable for molding applications. And the final objective is to establish the rate and extent of microbial degradation of plastics containing starch.

Successful achievement of objectives one and two would provide the improvement needed in starch-based plastic compositions and possibly open up large new multi-billion pound markets for starch. Achievement of objective three would provide a relatively simple and standard technique for measuring microbial degradation of these systems.

I will outline some additional examples of the type of research being conducted by ARS in this area of non-food uses. Useful products are being made from soybeans, such as printer's ink—and I heard that mentioned by Senator Bond earlier this morning—which now require 300 million pounds per year of petroleum-based oil. A soybean oil substitute would use about 25 million bushels a year of U.S. soybeans. Biotechnological research is being applied to use soybean oil to replace imports of castor oil.

Novel catalysts are being investigated for preparing lauric acid with a view of replacing coconut and palm kernel oil imports. Soybean oil is being developed as a fuel for farm tractors, to make cosmetics, specialty lubricants, and other high value products. I list in my complete testimony additional undertakings at this point.

ARS and the university system are engaged in a number of other research programs with the aim of developing new agricultural crops and products such as kenaf, cranby, rape-seed, as well as working toward the development of new products for traditional crops such as corn and cotton.

You will note in my prepared statement there are several examples of this type research. ARS funding for the total program for non-food uses is approximately $42 million. I should comment just briefly on that, Mr. Chairman. I heard your figure of $6 million and I also heard the figure $1.7 million, and Dr. Doane can probably break that down, if you wish. But $42 million is spent on non-food uses throughout the system. The reference you may have had is primarily in the laboratory at Peoria alone.

Chairman GLENN. Okay. The figure we had on that was—that was 1986 figures. Now, your figures may be updated. May be we are expanding that and I hope we are because that is what I have been pushing for for a long time, as you are aware.

The $6 million figure was out of 1986 where we had $510 million ARS total budget and we had $6 million in non-food uses. I think that figure came from the Department itself.

Mr. LONG. That is probably correct for that period of time.

Chairman **Glenn**. Have you expanded from $6 million up to $40-something million now?

Mr. **Long**. Well, we have $42 million that we can identify, yes, in total ARS system.

Chairman **Glenn**. Good. We are moving in the right direction. That still isn't a very high figure compared to the overall ARS budget.

Mr. **Long**. We will not argue that it is enough, but we are at least moving in the right direction, as you say.

Chairman **Glenn**. Good.

Mr. **Long**. Mr. Chairman, I am aware of your questions regarding economic projections on the amount of corn and other commodities that could be utilized by new products. However, at this stage in our research program we are not prepared to issue such projections. It should, however, be quite obvious that the potential economic value could be and would be very significant. The USDA, of course, will defer to the General Services Administration and to the Environmental Protection Agency on the provisions of that portion of S. 2298 dealing with the cataloguing and purchasing of biodegradable products.

Section 8 would require the Secretary to report to the Congress as to the research and development on new uses of agricultural commodities. This process really isn't necessary in that we can and we do provide that information with those requested in this section on a regular basis.

Mr. Chairman, USDA shares your interest and concern for the development of the new agricultural products. I personally believe that you are clearly on the right track and I thank you for the opportunity to appear before you and the Committee today. Thank you.

Chairman **Glenn**. Dr. Doane, do you have anything to add to that while we are getting started here?

Dr. **Doane**. No, only if you have specific questions that I might address.

Chairman **Glenn**. Good. Thank you.

Ms. Lowrance, you did not comment earlier.

Ms. **Lowrance**. No.

Chairman **Glenn**. All right. Thank you. We appreciate you being here and we appreciate those remarks this morning.

As you say, Mr. Long, we are up to $42 million, and I think obviously, that is a quintupling or whatever it is over a couple years period here; $42 million is still a small amount compared to the $500 and some million, and I don't know what the current budget is, but the 1986 figure was $510 million going into ARS.

Mr. **Long**. It is about $550 million now.

Chairman **Glenn**. Is it planned within the Department, as a general question, to keep moving up in this area in non-food uses? Do you see this as promising enough that we can expect in a year or two see $100 million in this area, or $150 million or something like that where we really move into this research area?

Mr. **Long**. I think there is a clear awareness on the part of the Department and the agencies and the university system to increase their research efforts in this broad field of non-uses of agricultural commodities.

It might be that Dr. Doane has something specific that he could add to that response.

Dr. DOANE. I am not sure what the percentages are, but I have responsibilities for seven projects, all of which address new uses for starch and of our budget, about $20 million at the Center, about one-third addresses directly new non-food uses, technology leading to non-food uses. The Center is only one of four regional centers and as Secretary Long said, then you also have research going on at the universities.

This has been my area of interest for a number of years and I have seen a dramatic increase in the funding in this area within our agency, so I assume it is going to increase at some point and some level, but I am not sure what that will be.

Chairman GLENN. I know you undoubtedly want to see more come into the research area, as I do, and I think just not to be super critical of the Department of Agriculture or anything like that, but I think through the years it has been looked at as one of the more immovable organizations in Washington, DC, and we are trying to get them to move off the old production emphasis, which has been pre-eminently successful, just tremendously successful. It has been one of the greatest research stories of all time, what has been done on production research within USDA.

Now we need to move into some other areas, and trying to at least get some emphasis over in this other area has been like trying to push the Rock of Gibraltar around. And so I hope there is this movement and this new excitement.

I get excited about these things, and I know you do too, where the new uses can be generated, and I just hope we can continue getting more money over into that area.

Mr. LONG. We share your enthusiasm, Mr. Chairman.

Chairman GLENN. You mentioned that the claims of biodegradable being made for any plastic containing starch are overstated and misleading.

Do you think we are going too far?

Dr. DOANE. May I address that, Mr. Chairman?

Chairman GLENN. I thought what we are addressing here was pretty much within our doability range right now.

Dr. DOANE. One of our projects with the group addresses this concern. We are seeing all sorts of statements, and when you use the term "biodegrability," it has certain definitions to certain of us and it has different meanings to others, and your prior witnesses addressed this concern also. From a selfish standpoint, as we are looking to increase the amounts of starch that we can put into synthetic polymers—plastics is one of those areas—we need to know exactly what that composition is and how it performs, whether it is as a garbage bag sitting out on your back stoop or whether it is buried, and what happens to the properties, the strength properties and so forth, and what are the breakdown components of that.

That is not known and we have now initiated some research to identify in the laboratory a rather standard procedure so we can compare one composition with the next, and we are acquiring samples of the commercial products. We want to look at what actually is biodegraded, what is the extent of biodegradation, and then what are the products of biodegradation.

So we feel that those questions are very legitimate and valid questions. We think the answers are really not there.

Chairman **Glenn**. Well, I do not want to push this into areas where it would be dangerous or does any of the bad things that you are talking about, but it appeared to us that the uses we are talking about and what we want GSA to be involved with is quite doable right now and quite safely and no doubt about it. So that is the reason we are pushing on this.

Mr. DeProspero, you indicated in there the need for testing and that you did not want to go too fast on this. I agree with that. I think there may be a mistaken impression that this bill dictates the use of degradables in certain areas by GSA and that is just not the case. We are not dictating anything. What we asked GSA to do was to look at this thing and give us an estimate.

We want, with this bill, to give you a little money which will help move, because we know it is going to be slightly more expensive, but it appeared to me that that is a good investment to move this industry off dead center and get it going.

So if there is any thought that we are dictating that you move in certain directions, that is not right. It is for GSA to increase the purchases of these products, where feasible, and we want to gain working experience with these products. The authorization is for 3 years, a test period. We are not planning to make this a permanent thing into the indefinite future.

Was that your understanding, or do you feel we were dictating some things to you?

Mr. **DeProspero**. Well, it was not a question of dictating. It looked like we would be required or mandated to do this for all the plastic items.

My suggestion would be that we do a pilot, that we do a test procurement to see how it works, identify several items that we can get a feel for, get a feel for what it takes to develop the technical part of it, the impact on the user, see if the agencies will be acceptable to that.

Obviously, GSA does not use their own products. We only buy for other agencies, so we need that aspect. We also have another program of what we call our "New Item Introductory Schedule." It is a procurement program that we are considering right now having—a contractor is working with us to come in on this schedule. It is feasible that we could put plastic products in a schedule, a biodegradable type schedule and see how that fits with agencies. It would have to be a commercial product. We do not do the testing on it. We would rely on industry and their test results. So that is a possibility also.

Chairman **Glenn**. Good. My time is up and I will turn this over to Senator Pryor. I just wanted to say though, there was a comment made about a working group or interagency group. The bill does establish an interagency working group to coordinate and promote these things, so we took that into account, I think.

Senator **Pryor**. Mr. Chairman, I have a short opening statement that I would like to submit for the record.

Chairman **Glenn**. It will be accepted for the record.

[The statement referred to follows:]

Opening Statement of Senator Pryor

Mr. Chairman: I would like to begin by thanking you for holding this hearing so that this committee can join in the effort to promote the expanded use of our nation's agricultural products. Certainly the use for these products in areas other than their traditional field is full of fertile potential. I commend you and this committee, Mr. Chairman, for recognizing the possibilities of such uses, and for exemplifying your commitment toward reaching these goals by having a hearing such as this and most certainly through the introduction of S. 2298.

When we discuss the ways in which our nation's agricultural products can be used, seldom do we realize the vastness that we are addressing. Many of us have learned of the uses of corn byproducts in developing biodegradeable plastics, and I am hopeful that just as many of us know of the use of soybeans in producing a soybean ink. When we address these areas, those of us from farm states have a tendency to initially focus on the chance of increased profitability for our farmers. While this is surely something to be enthused about, we should also remember that these agricultural products have thus far shown an ability to be more environmentally sound than some of the products they might someday replace.

The leadership and desire of the members of this committee to explore the possibilities of the non agricultural uses of some of our nation's commodities is indeed exciting. I am also encouraged to see such an able panel assembled before us, especially Mr. Wayne Bennett. Wayne, as president and chairman of the American Soybean Association has shown a keen interest and unwavering committment in the expanded uses of agricultural products. I am certain that with the support from this committee and cooperation from all parties, many of our goals in these areas will soon become realities.

Senator **Pryor**. Mr. Chairman, I will try to be brief.

We have thousands of printing facilities, printing plants, newspaper shops all over the country and one of the major problems, as I understand, is how we dispose of waste ink. Now, we have talked a little bit this morning about a substitute petroleum-based ink, which is ink made from the soybean, soy ink. We will discuss that in more detail later.

Do you have any figures, Dr. Porter, on what it costs us to dispose of waste ink in our country? Do you have any sort of ball park figure?

Dr. **Porter**. I do not have that figure in front of me. Ink has been a difficult problem, particularly with the lead-based inks. A lot of people have changed from lead-based inks. Probably the two major problems in landfills are lead and cadmium. Printing ink has been one place where we have found lead. I do not have any numbers right off the top of my head on what they cost, however, it is substantial.

Senator **Pryor**. Is there any interface in the cabinet or government-wide, for example, with GSA, with USDA and the other agencies of Government? Does everyone know what the other hand is doing now? Are we at that point. Does USDA know what your shop is doing at all times and vice versa?

Dr. **Porter**. One of the things I am going to talk about on Thursday in my press conference on the overall solid waste picture is that Government entities need to coordinate better. For example, we need to have Federal procurement regulations, that emphasize procuring recycled materials and other kinds of materials, perhaps biodegradable materials.

We work together on a wide variety of issues, but I think, the Federal Government could show more leadership in procuring recyclable materials, recycling itself and perhaps procuring degradable materials. That will be one of the challenges of the next Administration, but we want to begin to see if we could do a better job of procuring those kind of materials.

Senator Pryor. Has your office had a chance yet to look at the potential for ink made from a substitute such as soy ink? Have you looked at this potential?

Dr. Porter. Not specifically, Senator Pryor. We are certainly interested in it. We have come at it from the standpoint of primarily the lead being a troublesome component. We think that one of the things that is going to happen to the whole solid waste business is a lot of new formulations that are more benign from an environmental standpoint, not to mention you are talking about today, which is to use other materials.

I think we will be looking at as we move forward because we are going to have to. One of the things we are talking about these days is looking more stream by stream, because when you talk about solid wastes, the way you manage glass may not be the way you may want to manage ink or plastics, or something else. I think this is an area we will have to get into.

Senator Pryor. Well, I would really urge you to look into that magic soybean product, that is, soy ink, which is biodegradable.

I think now, Mr. Chairman, some 500 newspapers in the country are using soy ink, if I am not mistaken. In fact, I might just mention, I met some months ago with the Director of the Government Printing Office. I talked to him at length about the potential for printing the Congressional Record using no long petroleum-based ink but the ink made from the soybean. I said, you know, we have a propensity up here, the politicians do, and especially Senators, to talk on and on and the more we talked the more ink we would use and the more ink we would use, the more soybeans would be in demand. [Laughter.]

Chairman Glenn. And what is really constructive is the Congressional Record will biodegrade immediately. [Laughter.]

Senator Pryor. Some have even said there has not been a real test to see how long this soybean ink lasts, maybe it would fade. And I said, that might be an advantage for a lot of us.

But I do think it has a great potential. In a few moments we will hear from Mr. Wayne Bennett from the American Soybean Association, who happens to be a constituent of mine and a friend. He will have, I think, some very good facts and figures and I urge you to work with that Association.

I am very concerned, Mr. Chairman, really, that we do not have the interface and interconnection between all of the various agencies and departments so they will all know what each is doing.

I will have more questions and comments later.

Mr. Long. Senator Pryor, if I could make just one comment. The research on the soy-based ink is being done by the Department of Agriculture and there is quite a little bit on that. Dr. Doane knows more than I do on the development of it at this stage, but we thought an interesting aspect the development of kenaf, which is really a product that is biodegradable in its own right and it is coming along as a substitute for pulp wood. And combining that with a soybean-based ink, maybe you could read your paper in the morning and then have it for breakfast. There is a possibility for that. [Laughter.]

Senator PRYOR. Well, I urge you, when that report is complete, or ongoing during that study, to share information with the General Services Administration and certainly the Environmental Protection Agency and the other agencies of Government.

Chairman GLENN. The prospect of eating our own words.

Just one further question for Mr. DeProspero. We have very strict rules on competitive bidding and so on. Does this interfere with this? Because we know that to move into this area, it is probably going to be slightly more expensive; estimates are between 10 and 15 percent.

We are giving you some money, if this legislation goes through, to try and help do this within GSA itself. How about your client agents around the Government here. Are they going to be free to move into this on their own initiative? Or is this going to be a problem for them under our competitive bidding and procurement rules.

Mr. DEPROSPERO. No. They would be free to buy the product. It would be their decision.

Now, if you are talking about the new item schedule that I mentioned earlier——

Chairman GLENN. I meant even if it is a little bit more expensive here to get this thing going. Are they free to move into that or is competitive bidding going to prevent them from doing anything except taking the lowest bidder, which would eliminate some of these temporarily.

Mr. DEPROSPERO. We would have to go with the lowest bidder.

Chairman GLENN. That may be something we will have to address, too.

Go ahead.

Mr. GORMLEY. Mr. Chairman, I think their budgets have a lot to do with it and I think by trying to sell increased price products and the quality and then the time I think would not entice them to go for that higher priced item, and I think the New Item Introductory Schedule is an immediate way to go. You have biodegradable bags now, and so do we. We have been working with a potential supplier and they have indicated to us last week that the price may not be that different. It depends on how long or what time requirements that you are going to place on the product to actually biodegrade.

Chairman GLENN. Good. I hope we are reaching that stage very rapidly. That is good. If we are, then we are really beginning to make some progress.

We are going to have to move on to the second panel.

I did not see Senator Levin come in. I am sorry. Go ahead, Carl.

Senator LEVIN. I just have a couple of questions for this panel.

Chairman GLENN. Good. Proceed.

Senator LEVIN. First, Mr. Chairman, this I think is to Dr. Porter.

You testified that plastic wastes are one part of a larger solid waste problem, and you were critical of S. 2298 for dealing with plastics and solid waste disposal on a piecemeal basis and indicated in your testimony that you want to deal comprehensively with the solid waste disposal issues, I think those were your words.

What is your timetable for your presentation of that comprehensive answer?

Dr. **Porter**. Senator Levin, we are going to do a press conference on Thursday, where we will lay out a new strategy for solid waste management. We will address things that we are going to do and what we want others to do. We are putting it out for comment and hope to finalize it later this Fall. We have finished about a 6-month study and are reporting this week on where we stand concerning overall strategy.

Senator **Levin**. Will that address this issue?

Dr. **Porter**. It certainly will. It will not provide all the answers, but it will address plastics, glass, aluminum, and other issues that we are working on.

Senator **Levin**. And your Thursday press conference is going to announce some proposed regulations or a timetable for the issuance of proposed regulations?

Dr. **Porter**. It will announce some work that we are doing on regulations, but more importantly, what it is really going to do is talk about the overall strategy for dealing with the overall solid waste issue, some of which will involve regulations such as landfills, which we have already issued. Others will be more procurement directions and other items that we want to talk about.

So it is really kind of an overall game plan on what we think the country ought to be doing on solid waste management, and what EPA specifically will be doing.

Senator **Levin**. OK. You testified, Mr. DeProspero, that legislation directing the GSA to include degradable plastic products on GSA purchasing lists is unnecessary legislation or premature legislation.

Would you agree that some of these products at least are ready now?

Mr. **DeProspero**. Yes. I think I mentioned it to one of the staff people that I think that probably the best approach to this might be to identify—a test procurement might be to identify several products and see how they fare.

Senator **Levin**. Some of these products are being used now, aren't they, in the commercial world?

Mr. **DeProspero**. I understand that they are. I am not that familiar with the products being used commercially.

Senator **Levin**. Well, they are. I can tell you from my own experience.

Do you know if there are any such products on the GSA list right now?

Mr. **DeProspero**. I do not believe so, but we are considering putting—I mentioned to the Chairman that in the new item schedule we have a contractor that has come in and asked up to put on the schedule a plastic bag that is biodegradable. We anticipate to have that on schedule within the next probably 2 to 3 weeks, which means that agencies will have access to that product and we can see what the selling price would be and see even how the agencies accept the product.

Senator **Levin**. Now, when you say it will be on the list, do you mean that this would be an option to other plastic bags, that it would be left up to the agencies to decide?

Mr. **DeProspero**. Other manufacturers could come in and get on this schedule also. Is that what you are asking?

Senator LEVIN. No. Would there be any preference stated for the degradable ones?

Mr. DEPROSPERO. No. In the Federal supply schedule, it is a little program. They are commercially available products and we negotiate those off of their retail price.

Senator LEVIN. Would you support a pilot program for granting favored status to these products if they were within reasonable price competition?

Mr. DEPROSPERO. Say that again.

Senator LEVIN. If these products are reasonably close, price-wise, to the nondegradable products, would you favor a pilot program to give the degradable plastic products favored status?

Mr. DEPROSPERO. I would think that that is probably in the best interest of the country that we could give it that type of preference.

Senator LEVIN. Good. Thanks. Thank you, Mr. Chairman.

Chairman GLENN. Thank you. David, did you have any other questions here?

Senator PRYOR. No.

Chairman GLENN. Thank you all very much. I have just one final comment.

Dr. Doane, you must find this exciting in some of your lab work up there. I know people do not look at that as being necessarily exciting sometimes, but you can have an impact on some of these things that is so far-reaching it is just almost—I get quite exuberant even thinking about what the outcome of some of this can be and I am glad the research budget from DA is moving up at least from $6 million up to $42 million. That is still a pittance compared to the opportunities we have in research, I think, and I know running a laboratory or being part of a laboratory, you would not probably disagree with that.

I will not give a whole campaign speech on this, but I think this country got to be what it is by research and education, those two things, more than anything else, where we just excelled around the world. Now we are being challenged in some of these areas. They are beginning to out do us in certain areas; not necessarily all in agriculture, but in other areas.

I just think taking the lead and then being able to move these products from your laboratory and others around here rapidly into common use, with what little incentive we may be able to give, is so important, and that is what this is all about. So we look forward to working with all of you here.

Thank you for being here this morning. We would appreciate your rapid response to any questions other members or staff may have that will be included in the record when you respond. Thank you very much for your cooperation.

Our second panel this morning represents private and State interests; Steven Wentworth, First Vice President, National Corn Growers Association, St. Louis; Wayne Bennett, Chairman, American Soybean Association, Lonoke, Arkansas; Dr. Albert Manville, Senior Staff Wildlife Biologist, Defenders of Wildlife, Washington, D.C.; And David Buckner, Director, Office of Solid Waste Management, Illinois Department of Energy and Natural Resources, Springfield Illinois.

Gentlemen, we welcome you this morning and look forward to your testimony. As I said before, we would appreciate very much if you can keep your comments to 5 minutes. Your longer statements will be included in the record. We have so many people that wanted to be part of this this morning that we had to put more on than we normally do, so we are sorry we have to do that.

Mr. Wentworth, we would be glad to have you start off this morning, if you would like. Mr. Wentworth is First Vice President, National Corn Growers Association.

TESTIMONY OF STEVEN WENTWORTH, FIRST VICE PRESIDENT, NATIONAL CORN GROWERS ASSOCIATION, ST. LOUIS, MO [1]

Mr. WENTWORTH. Mr. Chairman, members of the Committee, I am Steve Wentworth, First Vice President of the National Corn Growers Association and a farmer from Oreana, Illinois. I appreciate the opportunity of testifying today on S. 2298, the Agricultural Commodity-Based Plastics Development Act of 1988. I would like to summarize my comments.

The National Corn Growers Association has made a long-term commitment to developing new uses and new markets for corn and corn products. While growth in the established markets, exports, animal feeds, ethanol and sweeteners is encouraging and important, vast new industrial uses offer even more hope for the future.

I would like to bring you up to date on two new uses which we are using our renewable resource—corn—to help solve environmental problems facing our Nation while at the same time providing a new market for corn: degradable plastics and calcium magnesium acetate.

Many local and State governments are facing a crisis regarding solid wastes. Plastics represent 7 percent by weight and 30 percent by volume of solid wastes buried in our landfills. It is here, the plastic segment of solid wastes, where agriculture can play a role. Degradable plastics, a blend of corn starch and synthetic polymers, can be a part of the solution to our solid waste problem.

The City of Lincoln, Nebraska, and the Nebraska Corn Development Utilization and Marketing Board have joined together in a degradable plastics demonstration project. Some 1,400 Lincoln residents were asked to place their yard wastes in specially marked degradable bags that contain 6 percent corn starch. These bags containing yard wastes will then be processed into compost, which will allow more efficient use of the City's new landfill site.

If this project was used for all of Lincoln's yard wastes, it is estimated degradable bags could potentially save the City $100,000 in costs and lengthen the life of the landfill. We feel the degradable garbage is a first step in offering a solution to our solid waste problem. But we also need to take a long look at developing other degradable plastic products where applicable.

Plastic products such as milk jugs, oil bottles, food trays, foam cups and polystyrene containers are currently in the final testing stages to be made degradable and are moving rapidly toward commercialization. Additionally, research needs to be continued to improve and expand the use of corn starch in many plastic products we use. It is estimated that potentially a 150-300 million bushel market for corn could be created through the use of degradable plastics.

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[1] See p. 110 for Mr. Wentworth's prepared statement.

Chairman GLENN. Could I interrupt for just a second. We just went on a vote. I am going to run vote and try and be back so we do not have to disrupt the hearings, and David will chair while I am gone here. He might have to come over and vote himself before I get back, so we will continue with your testimony here.

Mr. WENTWORTH. Okay. Currently the drought is on everyone's mind. Will there be enough supply? Will the United States have to import certain agricultural needs? We have only to review history. The same questions were asked in 1983 and then 2 years later we were discussing record breaking surpluses. New product development and market introduction is a long, arduous and expensive process. It requires commitment, discipline and persistence. We need a long term and consistent national commitment in the development of new agricultural products for industrial uses.

The Federal Government needs to increase the amount of research dollars for utilization research. We need to provide a means to take our research and technology from the laboratory to the marketplace. S. 2298, the Agricultural Commodity-Based Plastics Development Act of 1988 helps in this effort. By promoting the development of degradable plastic markets from agricultural based products and providing the incentives for further technology development, we will be able to increase our efforts in the private sector. Also, the establishment of an interagency working group will help provide the coordination and cooperation that is needed in developing a national program. The effort of utilization research and market development needs private and public cooperation.

The development of new industrial uses and markets from our renewable resources, agricultural products, will provide for a viable agricultural economy in the future. It will also help establish new industries, employment and economic activity in our communities. And it will also help us to be competitive in the world marketplace.

Mr. Chairman, the National Corn Growers Association commends you for your efforts and looks forward to working with you and the Committee.

Thank you.

Senator PRYOR. [Presiding.] Mr. Wentworth, I thank you. We are in a vote confirming the new Secretary of Education. I think in the interest of time and also due to my desire that Chairman Glenn hear our next panel that I am going to recess for 10 minutes and then we will both return.

Thank you very much.

[Brief recess.]

Chairman GLENN. The hearing will resume. I am sorry for the delay, but that is the nature of things here when we have votes on.

Where were we? Who was in the middle of their statement?

Mr. WENTWORTH. I had just finished.

Chairman GLENN. All right. Good, Mr Wentworth.

Mr. Bennett, proceed.

TESTIMONY OF WAYNE BENNETT, CHAIRMAN, AMERICAN SOYBEAN ASSOCIATION, LONOKE, AR

Mr. BENNETT. Mr. Chairman, I am Wayne Bennett, a soybean farmer from Lonoke, Arkansas. I am Chairman of the American Soybean Association, a national nonprofit organization representing U.S. soybean farmers in 29 States. I will summarize my remarks and ask that my testimony be placed in the record.[1]

ASA appreciates the opportunity to appear before the Senate Governmental Affairs Committee to discuss alternative uses for soybeans. As most people are aware, the major products made from soybeans are soybean meal, a high protein concentrate used in livestock and poultry feed, and soybean oil, a vegetable oil low in saturated fatty acid used in food processing.

However, there are other uses for soybeans, such as soy flour, varnish, makeup and paint. In its current state, S. 2298 deals mostly with plastics, but the Committee may wish to add a section to the bill dealing with the other environmentally sound alternative agricultural commodities such as two of the most promising soybean alternatives—soybean oil-based ink and soybean oil used as a dust suppressant.

The American Newspaper Publishers Association initiated the development of soybean oil-based ink due to quality and environmental demands. Soybean oil-based ink is approximately 80 percent soybean oil and is an acceptable alternative to petroleum-based ink. The advantage of soybean oil-based ink includes soybean oil is readily available at competitive prices for color ink and is consistently high quality. Soybean oil-based ink has less rub-off and gets better mileage on the press. Soybean oil is biodegradable and should be environmentally safe.

Mr. Chairman, allow me to expand on the environmental issues surrounding soybean-oil based ink. Currently disposal of waste petroleum products is getting more difficult and expensive. Since soybean oil is a vegetable oil, it is much easier to handle and could be a totally biodegradable product if the correct solvents are used in wash-up and it a biodegradable resin is developed. Research into these areas are currently underway. ASA strongly encourages Congress to assist in funding research which will expedite the development of a product which will be completely biodegradable.

Congress should also consider funding research to facilitate the use of soybean oil ink in glossy paper. Currently it cannot be used for heat setting on glossy paper, not as the result of any inherent difficulty with the oil but because no formulas have yet been developed.

Over 500 newspapers in this country are currently using soybean oil-based ink. Color pictures printed in soybean oil-based ink are winning the major photo contests because soybean oil-based ink provides a clearer, sharper reproduction. All of the above factors combine to show that the product is successful and that the potential market is staggering.

I have a copy with me of Representative Vin Weber's Congressional newsletter printed in soybean oil-based ink. He and Senator

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[1] See p. 117.

Paul Simon were the first two members of Congress to print their newsletters using soybean oil-based ink. ASA encourages other members of Congress to do the same. We further believe that Congress should encourage the Government Printing Office to seriously consider using soybean oil-based ink.

Turning now to the use of soybean oil as a dust suppressant. For decades the American grain industry has been searching for an effective solution to the problem created by grain dust in elevators and processing facilities. The use of edible oil to reduce dust in grain elevators dates back to 1951. Laboratory tests have shown that the application of soybean oil at as little as 150 parts per million is effective in reducing almost 100 percent of grain dust, thus reducing the risk of explosions, health and environmental safety hazards.

In summary, researchers have found that a dust suppression system which uses soybean oil has several advantages, including it can be installed for an average cost of $1,000 to $3,000, which is a significant cost savings over mechanical dust collection. At most, only a minimum backup dust collection system is needed.

Soybean oil keeps equipment and facilities cleaner, which reduces the maintenance and housekeeping and in some cases lowers the insurance rates. It improves workers 'health, attitude and safety. Less grain is lost in processing. Soybean oil has the approval of the Federal Grain Inspection Service and the Food and Drug Administration.

Applying soybean oil to livestock and poultry feed has also been shown to significantly reduce the amount of airborne dust in the feed. In fact, research indicates adding just 2 percent soybean oil cuts dust by 98.6 percent. Dust is potentially dangerous not only as a carrier of pathogenic microorganisms but because of its direct adverse effect on the respiratory tract of livestock and people.

These are just two new uses for soybeans. In both cases, the soy oil market demand is affected. It is important to realize that for every one cent increase in the price of soybean oil the farmer realizes 11 cents per bushel increase in the price of soybeans, and income derived not from the Federal Treasury but from the open market.

The soybean industry today faces new challenges as researchers attempt to develop new uses for soybeans. The American soybean farmer checks off about $3.5 million of their sales annually to assist in funding research aimed at promotion and development of new uses of their product.

With the continued research investment made in the cooperative nature by farmers, universities and the Federal Government, more new industrial and food uses for soybeans and soybean products will be forthcoming. Additional Federal resources, however, should not be at the expense of existing production and utilization research but should be as a result of increased Federal research expenditures.

Once again, thank you, Mr. Chairman, for the opportunity to discuss this exciting area, and I will be happy to answer any questions from the Committee.

Chairman GLENN. Thank you, Mr. Bennett. We will save that until we get all of the panel's testimony here.

Dr. Albert Manville, Senior Staff Wildlife Biologist, Defenders of Wildlife, Washington, D.C. Dr. Manville, welcome.

TESTIMONY OF ALBERT M. MANVILLE, PH.D., SENIOR STAFF WILDLIFE BIOLOGIST, DEFENDERS OF WILDLIFE, WASHINGTON, DC

Dr. **MANVILLE.** Thank you, Mr. Chairman. I also brought my bag of plastic demonstration items this morning. I wish, perhaps, the coffee cups here in Congress could be made out of biodegradable plastic, but we will work on that one later.

I am presenting this testimony this morning on behalf of 33 organizations in The Entanglement Network Coalition which I chair. With your permission, I would like to add the National Audubon Society and Clean Ocean Action to the list of signers onto this testimony. The Network's combined membership represents well over 10 million American citizens.

I have been asked today to provide our views on growing environmental problems concerning solid waste management, the potential contribution of degradable plastics in meeting this challenge, and the role of the Federal Government in addressing these problems. I think in our previous panel, Mr. Porter from the EPA did a fine job of giving us an overview of the problem. We have all probably read the Time Magazine and Newsweek cover stories and, of course, you may have recently seen this past Sunday the rebroadcast of Hugh Downs', "The Poisoning of America," which is quite frightening.

So that, I think, without belaboring the point, pretty well portrays the problem of plastics. They are indeed a worldwide problem, from pole to pole, every ocean and many of our freshwater lakes.

Last July I was fortunate to go to Alaska, the outermost Aleutian Islands, on board the U.S. Fish and Wildlife Service's research vessel, the *Tiglax*. The purpose of my trip was to conduct surveys of beaches up there in the Aleutians for plastics. I conducted 25 surveys on seven islands, including Attu, which is about 1,600 miles west-southwest of Anchorage, so it is quite a ways out.

The amount of plastic I discovered on these beaches was truly astounding and I brought a few samples here of some of that plastic this morning. Materials were identified from Japan, Korea, mainland China, Taiwan, Russia, Norway and the United States, and a host of others that I was not able to identify.

As I came ashore in a Zodiac onto our western-most beach in North America on Attu Island, 13 bull Steller's sea lions were basking on a rocky beach. One was resting his head on a plastic buoy. Another was sleeping on a plastic trawl net. My survey of a 100-yard section of this beach resulted in a find of 511 different plastic items of 27 distinct varieties, including bottles, buoys, crates, plates, fishing nets, rope, hard hats, PVC pipe, toothbrushes, coolers, even three National Marine Fisheries Service drift cards, which I brought along this morning here with some 6-pack yokes; so, an unbelievable amount of plastics.

Not to belabor the point but just to reinforce it, one of the bull Steller's sea lions that I photographed had a strapping band scar around its neck. I found hundreds of dead sea birds, some wrapped in plastic, so it looked like they perhaps may have had their demise because of plastic.

There was also a disturbing steep decline in the sea lion population noted in the Western Aleutians. So even on these remote beaches, perhaps the most remote in North America, plastics appear to indeed be taking their toll.

While we in the Network perceive the use of degradable plastic as critical to alleviate the adverse impact of plastics on fish and wildlife, we recognize that degradability is no substitute for proper disposal of plastic waste. While degradability is one part of the overall solution to plastic waste disposal, the problem will only be ultimately solved by a combination of efforts, including use and resultant waste reduction, recycling, degradability, use of biodegradable non-plastic alternatives, shredding and composting and, of course, enforcement of existing laws and regulations on dumping.

Members of this Committee as well as Congress must be cognizant of quick fixes and apparently readily available solutions to our plastics waste crisis. While degradability will require considerably more research, we need to immediately work toward recycling and waste reduction efforts. While preliminary results indicate that agricultural commodity-based plastics can be produced which degrade in the environment under certain conditions, including composting, they break down no faster than everyday non-degradable plastic products when subjected to deep landfill conditions. Therefore, again, degradables will require more testing, research, and development which we have called for in our comments.

Ultimately, Congress needs to begin seriously considering placement of a limit on the amount of virgin plastic produced and sold in this country. Since most plastic is made from petroleum, a resource that we are told we will run out of in about 30 years at continued and projected rates of increase, we must immediately take steps at nationwide recycling, non-degradable plastic reduction—which is of course called for in this bill—and use of non-plastic alternatives.

Passage of this bill will send a further message to the plastics' industry, product users, and the general public that Congress considers degradability a viable option in dealing with our plastics refuse crisis and that Congress is especially concerned about the impact of plastics on fish and wildlife.

We in The Entanglement Network Coalition, therefore, strongly endorse this legislation, along with our suggested changes and additions, and we hope the members of this Committee will do the same.

Thank you, sir. That completes my testimony.

Chairman GLENN. Thank you very much. Next is Dr. David Buckner, Director, Office of Solid Waste Management, Illinois Department of Energy and Natural Resources, Springfield.

TESTIMONY OF DAVID S. BUCKNER, PH.D., DIRECTOR, OFFICE OF SOLID WASTE MANAGEMENT, ILLINOIS DEPARTMENT OF ENERGY AND NATURAL RESOURCES, SPRINGFIELD, IL [1]

Dr. **Buckner**. Mr. Chairman, the State of Illinois thanks you for this opportunity to present its solid waste programs and State perspectives and to comment on the Agricultural Commodity-Based Plastics Development Act of 1988, your proposed legislation.

First, let me afford a bird's eye view of the State of Illinois. In Illinois, we dispose of 52 million cubic yards of waste each year; 95 percent of that waste is deposited in 146 landfills; 3 percent of that waste is incinerated in the State's one incinerator, and somewhere in the neighborhood of 2 percent is recycled. We estimate that we have 4 to 6 years of remaining permitted landfill capacity in the State and the landfill citing decision lays in the hands of the units of local government to such a degree that fewer than five new facilities have been cited in the State since 1982.

As a result of the diminishing landfill capacity, in 1986 Governor James Thompson introduced a solid waste initiative which resulted in the passage of the Illinois Solid Waste Management Act. That Act established as policy the pretty much familiar hierarchy of waste reduction, recycling, incineration and landfilling as a system for dealing with our landfill wastes.

The programs established under that act were to be funded by tipping fee surcharge on our landfills that would generate somewhere between $12- and $14 million a year. Over the past 2 years we have had the opportunity to watch this act in place and have this year established new incentives and new initiatives. First of all, the act and its tipping fee surcharge, which was a temporary surcharge, was made permanent. Second, we have established laws that require comprehensive solid waste planning and implementation of those plans, including the meeting of a 25 percent recycling goal for all our municipal solid wastes.

We have established heightened State Government recycling programs and we are going to use the proceeds from those funds to offset the costs for purchasing commodities made of recycled materials. We are requiring labeling of plastic for easier identification recycling and, lastly—perhaps most pertinent to this group—we are banning landscape wastes by July, 1990, from our landfills and requiring its disposal in biodegradable packages and containers.

As a result, I believe that the State of Illinois is about as well positioned as any other State in the Union to begin addressing the solid waste issue within our borders. But as with other states and other solid waste professionals, we are committed to that systems approach mentioned by Mr. Porter this morning for solid waste management. We believe that the same systems management strategy can be applied to waste subsystems. Plastics is one of those subsystems.

The challenge then is to develop a subsystem for dealing with our plastic wastes and, not to be totally repetitive, but that includes minimizing and reducing the amount of unneeded plastics we produce, developing recycling systems for plastics that are at least on a scale that we have for other commodities, determining the best applications for biodegradable and biodeteriorable plastics which can be defined and specified, and balancing incineration and landfilling in the most environmentally sound manner. It is that systems approach, in brief terms, that we would recommend looking into when we approach this issue.

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[1] See p. 116 for Dr. Buckner's prepared statement.

You asked us also to comment on Senate Bill 2298. From the Illinois perspective, the intents of that bill are proper and certainly well targeted. Degradable materials need to be developed and pursued for the role that they can play in the system. They are, however, not the solution, as most people have said today; rather, they have specific applications. I would call to your attention the high density polyethylene milk jug that you have which, yes, can be made degradable. But high density polyethylene is also very much recyclable and we should not pursue degradability where recyclability can come first.

If we only produce a system of degradables—that means more of those materials go into our landfills—then we are missing the point. The objective is to minimize that kind of material and to do things in the systems approach that makes the most sense. There are preferred options, obviously, and you have the means at your hands to pursue them.

With that, thank you very much.

Chairman GLENN. Thank you very much, all of you.

Mr. Wentworth, Mr. Bennett, have your organizations or have you done any estimates of the additional potential market that could result from the introduction of agricultural commodity-based degradable plastics? It would be a difficult figure to come up with, but have you made any estimate of the impact of this?

Mr. WENTWORTH. Yes sir, we have. We have come up with a figure of anywhere from 150 to 300 million bushels just on this product alone, degradable plastics. But as you know, we are going to highlight at a utilization conference in Columbus, Ohio, your home State, in November, we are going to talk about the whole area of new uses and we think that we can expand corn utilization to a far greater degree than what we have right now.

Chairman GLENN. Good.

Mr. BENNETT. In the case of soybeans and ink, if we use ink on the newspapers, we could use about 30 to 35 million bushels of soybeans. If we expand that to glossy print magazines, we would go up to 73 million bushels. And then if we could get the Government using it, there is not much telling what we could use. [Laughter.]

Chairman GLENN. What is our total soybean production?

Mr. BENNETT. We were expecting 1.9 billion, but since the drought we are talking now maybe 1.4 or 1.5.

Chairman GLENN. Mr. Bennett, is there any down side to the use of soy oil as a dust suppressant that you have mentioned here? In other words, does it contribute any to spoilage, or is this considered by some countries, if we are in international trade, to be a contaminant for future food use or other uses they might be making out of whatever the soybean product they would be manufacturing? Any down side to this at all?

Mr. BENNETT. Well, as far as we know, we have no down side. The Food and Drug Administration and Federal Grain Inspection have both approved it. Now, we are doing some research for milling purposes; say if you put soybean oil on wheat, we are doing some research to see if it affects the flour. We do not think it does, but we will have that information soon, we hope.

Chairman **Glenn**. Because in the area of international trade, you know, anything we add to something like this automatically raises suspicion on our part.

Mr. **Bennett**. Well, since this is biodegradable, you know, they have used other oils, but this is a vegetable oil and it is biodegradable. We do not see any problem.

Chairman **Glenn**. Just one comment. You said in the last paragraph you hoped the new research could be new and not taken from production research and I would hope that could be the case, too, but the budgetary restrictions being what they are, I am not too hopeful that could be done. I would still like to see some of the production—even if we stick with the current research budget we have for the Department of Agriculture, I would like to see more of it shifted over into new uses.

We have been so good at the production research, and that is good and I do not want to see that stopped, but I will tell you, I think we have some opportunities here in new non-food uses research that are just enormous.

Mr. **Bennett**. I agree with you.

Chairman **Glenn**. If we have to take it over from some of the production research for awhile, so be it. I would sure be glad to see some of that done if that is the only way we can get some money for it.

Mr. **Bennett**. I think we would support that.

Chairman **Glenn**. Mr. Manville, maybe I should know the answer to this but I do not. I know we are working on things that are photodegradable, light degradable and all of that. But if some of this stuff like you are talking about gets dumped at sea, does the cornstarch's degradability—does that occur in seawater as much as it would in a landfill? Do you know the answer to that?

Dr. **Manville**. In my discussions with Dr. Tony Andrady with Research Triangle Institute who is doing a lot of work on the degradable aspects of plastics for the Navy and other agencies, it is my understanding that there has been little if no research done on cornstarch-based plastic degradability in the oceans, so that is an area we need to see some research done. In fact, most of the plastic—both photo-degradable and biodegradable plastics—have not been tested, either in fresh water or in salt water, and he is doing work, for example, on the Hi-Cone Eco plastics.

Chairman **Glenn**. We have concentrated on our own landfill use and things like that. I do not know whether a corn-based thing like this, whether that is degradable at sea or not if it gets dumped off a boat. Does anyone know on the panel? Or anyone else in the room, as far as that goes.

Dr. **Manville**. Well, I can partially answer that, not being a biochemist, but just because of some of the things I've run across. Some of the plastics, for example, one that I am pushing—I am very interested in chitosan-derived plastic. It is made from chitin, which consists of the exoskeletons of shellfish, insects, and what have you. It breaks down by common bacteria, actinomyces, for example, that are found in the air and in our mouths. So if it were dumped at sea, I suppose it probably would break down. The question is, it has not been tested yet so we do not know, along with many of these other products.

Chairman GLENN. Mr. Buckner, you are proud that Illinois has taken the lead in this, and I think you should be proud of that. I compliment you and Illinois on that. But let me ask, what has been the general public reaction to some of the recent legislative efforts related to degradable plastics?

Dr. BUCKNER. I think, sir, that we would not have the legislation in place if the public weren't very favorable toward it. We see heightening landfill costs. We are very much concerned about the kinds of things that have happened on the East Coast not happening in Illinois and, therefore, the legislation that was enacted was enacted as a response to public outcry.

Chairman GLENN. Good. Senator David Pryor.

Senator PRYOR. Mr. Chairman, I am sorry I missed the testimony of some of our witnesses today. I especially apologize to Mr. Bennett, my constituent from Arkansas, that I missed his.

Chairman GLENN. He was superb, David. I will vouch for him.

Senator PRYOR. I have heard Mr. Bennett on several occasions and so he would be preaching to the saved if I was here. But I did want our distinguished Chairman, Senator Glenn, to have the benefit of your statement. I do apologize.

John, I might just say that Mr. Bennett is from a little town, Lonoke, Arkansas, and the population I would say 3,200 to 3,300. Some months ago I was privileged to attend a banquet in honor of Mr. Bennett upon his becoming the President of the American Soybean Association.

The banquet was also in honor of Mr. John Tull, who the same year was the President of the American Rice Growers Association. Mr. Tull lives within a block or two of Mr. Bennett. So there, in that small town in Arkansas, we have two very distinguished citizens who were occupying national roles in rice and soybeans.

Mr. Chairman, the American soybean farmers pay—I think the figure is something between $3 and $4 million a year in check-off dues to promote research and development for the American soybean. And a great portion of this money today is being used for the purpose of looking at new products that can be made from this magic commodity that we grow in about 25 or 26 of our States in the country. I would like to compliment Mr. Bennett on taking the lead in helping in this promotion.

He has just returned from a trip to the Soviet Union. The Soviets are major consumers or purchasers of American soybeans. I think that he will be going into Japan in late October on a mission.

Let me ask Mr. Bennett this question: Some years ago we heard about the soybean being used for biodegradable plastics. Is that still on track, or what is that possibility today?

Mr. BENNETT. Well, as you know, Henry Ford was the one that started the soybean industry in this country to make plastic for his Ford automobiles. We have not done enough research and at this time we need to do more, but we do not have enough research to say that we can do plastics in a commercial volume.

Senator **Pryor**. Do you feel today that there is a new recognition or sensitivity? Let's take first an environmental question. Are the environmental issues today being addressed as we attempt to promote not only the soybean but soy ink and the byproducts of the soybean?

Mr. **Bennett**. Yes. The Soybean Association is very active in that and we think soy ink is a prime example of what can happen environmentally, because as you know, the petroleum-based inks are creating a problem for disposal. So anything we can produce that is biodegradable, we think is good for the environment.

Senator **Pryor**. I believe, if I am not mistaken, that your home town newspaper is printed using soy ink.

Mr. **Bennett**. That is true. And while you were out, we heard Congressman Weber and the Senator from Illinois are using it to print their paper.

Senator **Pryor**. I just saw Senator Simon, Mr. Chairman, and I complimented him on being the leader in the Senate in utilizing soy ink for the publication of his newsletter.

Finally, let me ask if the Federal Government becomes more deeply involved as a result of the legislation that we are looking at—where do you think we target these research dollars? If you had to wave that magic wand and say, this is a priority or that is a priority, where do you think we should target these dollars?

Mr. **Bennett**. Well, I think the use is where we need to go with our money now, to develop new uses for soybeans and all agricultural products. As the Senator said earlier, we spend a lot of money on production, which is still necessary. We still have to be efficient producers and research is the only way we can do that. But I think it is time now to turn to utilization and the plastics with corn and the soybean ink with soybeans, I think, is a good place to start.

Senator **Pryor**. I recently read a column about 2 to 3 weeks ago by a nationally syndicated columnist sort of deriding and making fun of the soybean. He thought the only use of the soybean was soy sauce. I truly hope that this great national organization of which you are the head, will reply.

Mr. **Bennett**. Senator, I think we have corrected that. We put out a news release and called all our members and I assure you that columnist has a room full of soybean products now.

Senator **Pryor**. Very good. [Laughter.]

Mr. Chairman, thank you, and I want to thank the panel this morning.

Chairman **Glenn**. Thank you very much.

Mr. Manville, we do need a lot of research in this area of accelerated research to answer questions about rate of degradation and varying conditions at sea and in landfills and out in the open and whatever, and at the same time we need to get ready to manufacture these materials on a larger scale somehow. I hope that maybe some of the production can even be moving ahead as we answer some of these questions. I do not know whether that is possible or not.

Maybe we have to wait until the questions are answered. But the needed testing has to get underway and we are convinced that these things should be introduced as fast as possible. Our intent is to get these outstanding questions answered and not to prematurely introduce these materials on a large scale basis.

I just wanted you to understand that. I think one of your comments maybe indicated we might not be doing enough testing here before we moved ahead. But it is our intent to make sure that these things are safe before we move ahead.

Dr. MANVILLE. We feel that degradability is part of the equation in dealing with this whole problem.

Chairman GLENN. Just one further question of you, Mr. Wentworth and Mr. Bennett. You have mentioned several things here now. We know methanol. We have a big plant back home in Ohio that was supposed to be using about 24 million bushels of corn a year, I think, for methanol production down at Southpoint, Ohio. Soybean ink. David has addressed that here.

Those are two examples. Do you have other examples that you have followed through your associations that could give us any other indications of other uses that we see in the offing right now for whatever products?

Mr. WENTWORTH. Sure, I would be happy to, and maybe Dr. Doane from Peoria could comment, too. But there is a product called Vicara which can be used as fabric, and there has been some testing on it and several of the characteristics of this corn-based fabric are superior to the synthetic fabrics we are using now.

You have mentioned earlier in your comments about how the Japanese steal—have a tendency—not steal, but to utilize some of our technology. Well, they have taken a corn-based product and are incorporating it into the manufacture of tires. It is hardening agent. In this country the tire manufacturers use carbon. They are using a corn-based product to do the hardening of their tires.

We are using a product called calcium magnesium acetate, CMA, if you will, which is a non-corrosive, non-toxic replacement for road salt. And the list goes on and on and on. But we think with expanded research, what you are talking about in new uses, we can break out of what agricultural products have always been thought of in the past, and that has been dictated by the size of the human stomach, in this country and around the world.

We think if we are truly committed, we can bring out of this demand pie about this size and go into something about like this. Anything that can be made from a barrel of crude oil can be made from corn starch. I raise corn and soybeans and so I applaud the efforts of the American Soybean Association, soy ink. And I think the direction this country needs to go in agricultural policy needs to go into new uses, and I think that is what will bring profit back to the American farmer.

Chairman GLENN. Thank you. Mr. Bennett, do you have any further comment beyond ink and the other things you talked about?

Mr. BENNETT. Yes. Being from a farm state, I am sure you have heard the adage that the soybean is a miracle crop, and I am amazed. Every year we have come up with a new use, and I think that we have just scratched the surface. But just in dust suppression alone, we could use up to 23 million bushels of soybeans just using it in the grain elevators. And then if we started using it in feed, especially in swine production, we could use another 105 million bushels. So there are unlimited possibilities.

It is hard to put a figure on how many bushels of soybeans could be used with the proper research, and I think you are going in the right direction and I hope you success.

Chairman GLENN. Thank you. Thank you all very, very much. We appreciate it. We would appreciate your prompt response to any questions we might wish to submit for additional testimony. Your answers will be included in the Committee record and we appreciate your being here this morning.

Thank you.

Our third panel is from private industry. The first witness is Thomas J. Galvin, ICI Americas out of Wilmington, Delaware; Mr. Tom Byrer, Senior Vice President, Advanced Material, Battelle International Institute, Columbus, Ohio; Peter P. Hanik, Director, Applied Research and Technology Service, Quantum Chemical, USI Division, Rolling Meadows, Illinois, representing the Society of the Plastics Industry; and Mr. George Makrauer, President/CEO, AMKO Plastics of Cincinnati, Ohio.

Gentlemen, we welcome you all this morning. Mr. Galvin, we would be happy to have you lead off this morning if you would.

TESTIMONY OF THOMAS J. GALVIN, ICI AMERICAS, WILMINGTON, DE [1]

Mr. GALVIN. Mr. Chairman, as you say, my name is Tom Galvin. I am manager of new ventures for ICI Americas in Wilmington, Delaware. I would like to thank you and your Committee for your invitation to speak to the Committee on the important issues in S. 2298 and how they relate to ICI's PHBV biodegradable plastic.

I have submitted a written description which goes into considerable detail on the products and I want to use the time alloted here to highlight some of the more important points.

Our product is of bacterial origin. By this we mean that the products are produced by a particular strain of bacteria in a fermentation process. We feed the bacteria sugars—either cane sugar or corn sugar. They convert this to a biodegradable plastic much as a human would convert carbohydrate and protein into fat.

Our products are no different in physical properties from conventional plastics except they are biodegradable and biocompatible. When biodegraded in the soil they convert to carbon dioxide and water and they go right back into the environmental cycle to produce further corn through biosynthesis.

Our products differentiate from the other biodegradable materials in that we are a 100 percent biodegradable plastic made 100 percent from agricultural products. We are not a mixture of a biodegradable starch with a conventional plastic material.

ICI has been working on this product and this technology since 1976. Our contributions have been mostly in two areas—we have managed to simplify the production process, and more importantly, we have discovered variants that are more heat stable and thus are easier to process into films and bottles. And as you see, I have my little bottle as well.

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[1] See p. 174 for Mr. Galvin's prepared statement.

ICI currently has a variety of work underway on these biodegradable materials around the world.

Chairman GLENN. Could I ask, is that a mixture now?

Mr. GALVIN. That is a 100 percent biodegradable plastic material made 99 percent from agricultural raw materials. In this case, it was cane sugar, but we can easily use corn sugar.

Internally, our main objective is to get the manufacturing process for producing the material correct so that we can scale up beyond our current 100 ton pilot plant with some confidence. We also need to match properties to applications so that we can develop polymer systems that will perform to meet the requirements and at a proper price.

We currently sell the material—get your breath—at $15 per pound. Our goal is to get this price down close to $2 a pound, and this can only be accomplished by an increase in scale. Some people might even say that at $2 a pound we will still be very expensive relative to the 50 to 75 cent a pound commodity plastics now available. They are correct if petroleum feed stocks do not increase in value. We expect that they eventually will and that $2 a pound will eventually look very good.

In the U.S. marketplace we are developing markets that will depend on the plastics unique bio-compatibility as well as biodegradability. Some of the applications include orthopedic pins and plates, slow-release medicants and other low-volume applications where we would actually implant it into the human body. These applications do not depend on price nor do they depend on environmental biodegradability.

In the biodegradable area, the applications we are concentrating on are in packaging as well as in personal hygiene products, and these tend to be very high volumes and certainly legislation activity will have an effect on when this market develops. In this personal hygiene and packaging area we must be absolutely certain that our products will indeed function, that they can be processed into usable articles at no cost penalty, and that they have the necessary Government clearances, be they FDA, EPA, OSHA or whatever.

As you know, this is a time consuming exercise and we are working under some difficulty when there is currently no defined standard or test method for biodegradability.

S. 2298 certainly impinges on a number of elements of our products, but we are not sure that this particular bill gets us out of either the agricultural products surplus problem that we have or that it completely solves our plastic waste issues. Granted, any legislation such as we are addressing today that helps in getting us out of our waste dilemma is laudable and we entirely support them. However, we feel that it is only a part of the real solution which, in our view, has got to be a total waste system approach which will include degradability, recycling, as well as incineration.

One further thing on the bill, it does not address, as I say, what I believe and our coworkers believe is a key issue, although the GAO report certainly does comment on this. And that key issue is the establishment of standards for biodegradation as well as the establishment of test methods. Further, it does not address the identification of the other properties required by our customers and the filling of these requirements at a cost effective level.

We believe that with the latter, where the customer is involved, that the job centers on ourselves. The setting of biodegradable standards, however, we agree should be in the domain of the Government agencies.

Thank you, Mr. Chairman. I will entertain any questions at the end of the session.

Chairman **GLENN**. Thank you very much. I think we will go ahead with all the testimony first and then we will have questions.

Mr. Tom Byrer, Senior Vice President, Advance Material, Battelle International Institute of Columbus, Ohio.

Before we start, Senator Roth has just joined us. Do you have any comment, Bill?

Senator **ROTH**. Let me be very brief, Mr. Chairman, because unfortunately I have three meetings at this time. I would ask that my statement be included in its entirety.

Chairman **GLENN**. It will be so included.

[The opening statement of Senator Roth follows:]

OPENING STATEMENT OF SENATOR ROTH

Mr. Chairman, I am pleased to be here today. I think the subject of this hearing is important, from both an economic and environmental sense. I have always felt that we should expand the uses of our agricultural products, and am encouraged with some of the progress so far. The development of nonfood products such as biodegradable plastics from some of our agricultural commodities create new opportunities for our farming communities. In my opinion this is only the beginning for the development of new markets for agricultural commodities. I look forward to working with you Senator Glenn in recognizing the beneficial non food uses for agricultural commodities and to ensure our farming communities a progressive and substainable future.

I am also here to introduce Mr. Thomas J. Galvin. Mr. Galvin is a native Wilmingtonian, and is manager of new ventures, corporate resources, at ICI Americas in Wilmington, Delaware. He is here to testify on the legislation, and to tell you a bit on what the current status is of ICI's research in the area of biodegradable plastics. They produce those novel products through the fermentation of simple sugars. When the plastics are broken down by microorganisms such as fungi in landfills, only carbon dioxide and water remain.

Mr. Chairman, Mr. Galvin joined ICI's predecessor as a research chemist in 1958. Since his return from an international assignment in Brussels, Belgium from 1972 to 1974 Mr. Galvin has held several senior management positions. He assumed his current position in 1983.

Senator **ROTH**. I did want to come here to congratulate and agree with you on the importance of these hearings, both from the expanded use of agricultural products as well as the environmental implications. I think they are extraordinarily important and I look forward to working with you on this important area.

I am especially pleased to welcome to the Committee Mr. Thomas Galvin, who comes from Wilmington. We are very proud of having ICI Americas headquartered in our State. It is a very responsible citizen and we are always delighted to greet their members. I am sorry I was not here at the beginning of your remarks, but thank you for coming.

Mr. **GALVIN**. Thank you for those comments, Senator Roth.

Senator **ROTH**. Thank you, Mr. Chairman.

Chairman **GLENN**. Thank you.

Mr. Byrer?

TESTIMONY OF THOMAS G. BYRER, SENIOR VICE PRESIDENT FOR ADVANCED MATERIALS, BATTELLE INTERNATIONAL INSTITUTE, COLUMBUS, OH

Mr. **Byrer**. Thank you, Mr. Chairman. We appreciate the opportunity to be included, and I have been requested to present some observations about the state of the art technology on biodegradable packaging as well as perspective as what is achievable in the future.[1]

Nearly 13 billion pounds of plastic packaging materials were sold in the United States in 1987, and a significant amount of this plastic is discarded and creates the pollution question that we have been talking about today. A number of products have already been discussed that degrade by biological, photochemical and possible other mechanisms, and they represent an important part of the solution to our total pollution problem.

We have heard about the photodegradable products which need sunlight to degrade, the starch filled products which may have near-term applications. Mr. Galvin has talked about the ICI product. The new USDA product, which is, as I understand it, a composite film of starch and plastic, is moving towards commercialization.

We also have a product at Battelle that has been developed over the last 10 to 15 years. That is a lactic acid based product which comes from corn, and we are discovering it can also come from potato skins, which has not been mentioned here today, along with a lot of other materials.

Ours also degrades to carbon dioxide and water in a landfill. We also know it will disappear in salt water. One of the early applications that we are looking at here in discussions with a number of industrial companies is the application of this product in the fast food industry.

The glamorous side of research on degradable materials is the materials development side. However, what is doable will also be determined by state of the art in the evaluation methods that confirm degradation of the material to safe products and the estimated time for degradation to occur. Accelerated testing methods would allow all of the research to be done more quickly. We also need to observe and understand what happens in various environments--sea water, landfills, dry and wet, surface litter in dry areas and in wet areas.

This includes the fate of packaging materials and their effects on the environment. The more we know about fate and effects, the better we can put technology to work to solve these problems.

In summary, we see the plastics pollution problem being addressed in several ways. One, the pursuit of recycling methods and technology that are economically attractive; second, enhanced education of the general public concerning the true effects of plastic pollution on our environment; third, the design of total packaging systems that include recycling and disposal considerations; and fourth, as has already been mentioned, the accelerated research on new plastic materials that represent viable products for our U.S. plastics industry in meeting the demands of the marketplace.

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[1] See p. 187 for Mr. Byrer's prepared statement.

Thank you for the opportunity to provide these observations.

Chairman GLENN. Thank you very much. Next is Mr. Peter Hanik, Director of Applied Research and Technology Service, Quantum Chemical, USI Division, Rolling Meadows, Illinois, and he is representing the Society of the Plastics Industry.

Mr. Hanik?

TESTIMONY OF PETER P. HANIK, QUANTUM CHEMICAL CORP., USI DIVISION, ROLLING MEADOWS, IL, REPRESENTING THE SOCIETY OF THE PLASTICS INDUSTRY, INC.[1]

Mr. HANIK. Thank you, Mr. Chairman. On behalf of the Society of the Plastics Industry and my self I would like to thank you for this opportunity to comment on the content and objectives of Senate Bill 2298.

The Society of the Plastics Industry has over 2,000 member companies and SPI has been the voice of the plastics industry since 1937. They have asked me to speak because of our company's position in the plastics industry and because we are doing research into development of biodegradable products which include corn starch-based products.

The Society supports the objectives of Senate Bill 2298 to restore the vitality of the agricultural industry and help solve the solid waste disposal problems that exist in the country today. SPI does have concerns, however, that the bill is based on the presumption that the wide spread use of the products which are commercially available today would be a viable solution to the solid waste disposal problem. We do not see that this would in fact occur.

When we look at the technology of products based on corn starch today, we know that the incorporation of corn starch does reduce the mechanical and physicochemical properties of plastics when they are incorporated, but we do not in all applications understand just exactly what these effects are.

For example, we know that when 6 percent corn starch is incorporated into polyethylene used for grocery sack applications, we need to make the bags thicker to get the same strength that the bag would have if the corn starch were not incorporated. It is interesting that this actually results in 10 percent more plastic actually being used in the bag to make a bag of the same strength. If this has to be done, then obviously more plastic would go into landfills and this would not be contributing solving to the solid waste problem.

More work is needed in specific application areas. We have just begun to scratch the surface of how these products can be applied, so more research work we feel is needed in this area.

Almost everyone else has mentioned the issue of standards, and I cannot emphasize strongly enough the need to pursue this. Every company and agency that is doing research is pursuing their own concept of degradability. There are no generally accepted standards available today. The ASTM, as mentioned, is just beginning, and our company is supporting that operation.

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[1] See p. 196 for Mr. Hanik's prepared statement.

The agricultural economy, we have heard a number of estimates today as to how many bushels of corn could potentially go into these non-food applications, ranging from 100 million to as many as 500 million. I think Senator Bond had mentioned 500 million bushels. We know that there are about 50 billion pounds of plastics that are produced in the United States today and 70 percent of these go into long-life applications such as furniture and construction products and things of this nature. The remaining 30 percent go into packaging and short-life applications.

If one-third of these short-life application products could incorporate 10 percent corn starch, our figures indicate this would be 12 and a half million bushels of corn. All of these applications may not be technically feasible. They have not been evaluated yet. Therefore, we feel this is a rather optimistic estimate. If the number is 12 and a half million bushels, we feel that Senate Bill 2298 would not be a significant economic benefit to the agricultural industry at this time.

We know that solid wastes are very slow to degrade in landfills. Newspaper, for example, is readable after 20 years. And we also do not know what the effect of biodegradable products would be on recycling. There is a strong national and industry interest in recycling. We feel very enthusiastic about the potential of recycling to reduce our dependence on foreign oil, to conserve our own oil supplies, and the biodegradable plastics, we do not know if they can be incorporated into recycling systems. We have similar concerns for the whole topic of waste incineration.

With regard to procurement, the SPI believes that it is premature to establish a procurement preference because of the developmental nature of most of these products. We also feel that it is inappropriate for the Government to promote a single technology, in large part because many companies have been investing significantly in alternate technologies, and I think you have heard from people at ICI and Battelle about two of those.

In conclusion, the SPI supports the objectives of the bill but feel the technologies available today are still in a developmental state and that the estimates for the number of bushels of corn which could go into these applications is smaller than we would hope. We feel that the procurement preference is not appropriate for the Federal Government and we would encourage the Government to get involved in support for definition of requirements, support for recycling programs and development of technology for recycling and, in general, a total systems approach to solid waste management which would involve not only biodegradation but also plastics recycling and plastics incineration systems.

Thank you.

Chairman GLENN. Thank you, Mr. Hanik.

Mr. Makrauer, go ahead.

TESTIMONY OF GEORGE A. MAKRAUER, PRESIDENT AND CHIEF EXECUTIVE OFFICER, AMKO PLASTICS, INC., CINCINNATI, OH [1]

Mr. MAKRAUER. Thank you, Mr. Chairman. We appreciate the opportunity to appear here, and particularly for your effective demonstration of the strength of one of our products that you showed earlier. We would like to share some of the thoughts we had prior to the introduction and commercialization of this product and technology that we have been involved with, and also to share some of the thoughts and concerns that have come as a result of our introduction of this product.

Our company is a manufacturer of specialty plastic bags used by primarily non-food retailers throughout the United States. In addition to non-degradable bags, we are also producing bags with photodegradable additives in them, with corn starch degradable additives in them, and with additives that represent a combination of both the photodegradable and the corn starch degradable technologies.

We have been involved in investigating this technology and opportunities and responses to concerns about landfill issues over the last 3½ years. And in November of 1987 we introduced a program of corn starch degradable bags based on two technologies that were then offered to the industry, although not offered by any bag producers at that point. Since that time, the issue of degradable plastic films has become a major topic within our industry.

One of the findings in Senate Bill 2298 that has a twist to it and raises a concern with us is the contention that plastic products comprise a significant amount of the solid waste problem. One of our concerns is that in addressing what is perceived to be a significant problem—but currently we believe 7 percent is not a significant number, although one of importance—we are concerned that the amount of plastics contributed to the solid waste stream not be increased.

And here is one situation we are confronted with today. The majority of plastic film and plastic bag scrap generated throughout our industry has traditionally been and is continually recycled by manufacturers of the bags themselves and also for those who do not recycle their own scrap. The scrap is sold to people who manufacture garbage can liners.

Now, we have been told quite directly by the manufacturers of garbage can liners they do not want to purchase any of our degradable film scrap because they are concerned about the high performance, thin gauge product they must manufacture. So we are left currently with no alternative but to dispose of this scrap and currently the method of disposal is a contribution to the solid waste stream. One of our hopes is that the technology stimulated by this Act can contribute to addressing the issue of the recyclability of these degradable plastics.

One of the ironies that exists with the whole issue of degradability in plastics seems to be that for years the suppliers of the materials we buy and the resins we purchase, have been adding ultraviolet light inhibitors and antioxidants into the materials they ship us so their products do not degrade on their own after exposure, particularly to sunlight. So one of the objectives of the current demand on the technological development is that it not only initiate degradation in some situations, but also accelerate the degradation that would normally take place. We think research stimulated by this Act should address that particular aspect of the technology as well.

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[1] See p. 209 for Mr. Makrauer's prepared statement.

As has been mentioned by several people this morning, our major concerns have to do with the definition of degradability. Without having quantifiable standards which we can seek to meet with out product performance, we are at somewhat of a loss to describe precisely what it is our product is doing.

For example, with specific respect to the bill, to what degree must there be a loss of utilitarian or physical characteristics in complying with the definition of degradability in what has been proposed? At what rate must degradation take place? And this was exemplified this morning when one of the speakers made a comment that one particular supplier felt that he could produce a degradable product at a somewhat comparable cost to non-degradable materials, depending upon the amount or the rate of degradation required by the Act. This points out some of the variables that need to be addressed in the research; what are the acceptable byproducts of degradation, and a host of other questions that are detailed in our written testimony.

The future cost considerations of degradable plastic bags, specifically our product, will depend to a great deal on the technological development that takes place in the corn starch and the corn milling industry. That has been described to us. We think pricing will get closer to nondegradable plastics as the future unfolds and as additional technology is developed.

We believe that the uncertainties with regard to objectives, needs, definitions and standards about degradable materials, be they photodegradable or biodegradable or a combination, need to be addressed by this bill.

We appreciate this opportunity to comment. The complete text has been submitted to you and we would be glad to address any questions.

Chairman GLENN. Thank you very much, all of you.

Let me start off by saying I think maybe there was a presumption that I think that this is going to solve more of the problem than I really think it will solve. Mr. Galvin said he did not feel this bill gets us out of the problem. I do not think so either, not by a long shot. It is just a start. It is a toe in the door, as I saw it.

Mr. Hanik, I believe, stated that he had serious reservations out of a presumption that my legislation is based on—that the widespread use of commercially available agricultural commodity containing plastics represents a viable solution to the growing disposal problem, or words to that effect.

I share your views on that completely and this certainly is not the solution to any big problem, but it is a start. It is a toe in the door. I believe EPA testimony earlier here from Mr. Porter indicated that in 1986 the U.S. produced approximately 158 million tons of municipal waste. Plastics composed 7 percent, or 10 million tons, of that total.

So even if we were 100 percent effective with everything that we are even contemplating here, it would just be a nibble at the whole overall problem. But at least it is a start, and it is a start from two aspects, as far as I am concerned. One is, the landfill, the waste products, the things that we all know are problems that we are trying to face. And the other is, I am sick and tired, as I said earlier, of seeing us develop products in this country and seeing other nations then take them and run with them and become the world's supplier, and I can just see that happening in this industry. So we are trying to get ahead of the curve on this one instead of behind it and do some things that will help us move on ahead. And we have to consider things.

Mr. Hanik, you said that we have a situation here where we have to look at it because once we add corn starch we have to get thicker to retain the strength and we wind up putting more plastic in than we are preventing. So we have considerations like that. Obviously, we need a lot of study. We need to set standards. And you pointed out, Government should not promote a single technology. I could not agree with you more. This just happened to be one that we felt was an example of where we could move ahead. I just wanted to make sure that everyone understood where I was coming from on that one.

I guess what we are at with this and others is what is the Government's role in this? And I would appreciate each of you commenting on this. Like I said, I want to see us move ahead. I want to see where we make technological advances. I want to see us go ahead and develop the industries. Now, we can be so super safe that we wind up never getting there and other nations take our development and they run with it around the world and we lose the market, which has happened repeatedly in different areas—electronics and things like that.

On the other hand, I do not want to see the Government coming in and trying to do everything. I think the Government can serve as a catalyst in research as we have had throughout our history. It has been one of the success stories of this country, as I commented on earlier.

I do not know where we go. ICI has taken the initiative in a lot of these areas here and you are doing a good job. I would presume that you feel there is a tremendous potential market for this or you would not be putting your own dollars into the research and doing the product development that you are doing.

Would each of you comment on what you see as the Government's role? I am truly looking forward to hearing your answers on this. I will just tell you in advance, I am not predisposed to say the Government just stays out of it, like the Administration has said, if it is worth doing, private industry will always do it. The breakthrough research we have seen in the past, the Nobel Laureate seminal breakthrough, basic research, the basic—not development—the basic research breakthroughs in this country by and large have come from Government interest in colleges and universities or supporting a laboratory, or out of a Government lab itself by and large. Then we go ahead and develop these other things.

There have been some notable exceptions to that, Bell Labs and 3-M, Monsanto, some industries like that that have taken the lead, to their everlasting credit, in doing the basic research. And there is a balance here someplace and that is what I would appreciate your comments on, on what the Government role is and where we go with it and where do we jump in and give a catalyst—which we are trying to do in this bill—to getting it over the hump in the use of a certain product that we think is ready, and not just sit back and wait for some other country to pick it up and run with it, and where do we stay out of it. That is what we are grappling with here.

Mr. Galvin, would you lead off on that. That is a broad-gauge question. You can give a 3-hour dissertation on that.

Mr. **Galvin**. That sort of covers the waterfront, I would agree. But from ICI's perspective, as far as our particular product is concerned, I think that you will note in the GAO report that there is some research that is already being funded in various U.S. universities to the investigation of the improvement on the yields and the different strains of bacteria that can be used, as well as the different raw materials. We encourage that and would appreciate more of the same, please.

As far as the industry as a whole is concerned, in respect to biodegradation, it is obvious we need standard test methods and we need a clear definition of what biodegradation is. Again, also, I feel personally that I share your views. If we solve 7 percent of the problem, there is 90 percent left. I think there is an educational process that the Government could get involved in with the public, particularly in respect to incineration as well as landfill.

Incinerators can be run effectively and environmentally clean. We have a trash-to-steam plant in Delaware which is about a mile from one of our major chemical plants in Delaware. We buy steam that replaces the equivalent of 100,000 barrels of petroleum. That is just in little old Wilmington, Delaware. So the technology is there.

In respect to the landfills, the technology is available to collect the leachates, to put these leachates back in. I think there needs to be some correct management criteria put on these landfills so things that are entirely biodegradable such as the gentleman from Illinois was referring to, if they have to be biodegradable, and that sort of thing. That needs to be done as well.

So there is an education process that has got to be gone through and I do not believe that is the role of industry.

Chairman **Glenn**. Mr. Byrer, you represent one of the leading research institutes in the world, literally, and I do not overstate that. What role do you see Government playing? What research that you referred to there, what was done under a Government contract? What was done under private research contract with you? I believe most of Battelle—a high percentage of Battelle's work does come from Government contracts.

Mr. **Byrer**. Yes, about 60 percent of it totally.

Chairman **Glenn**. What role do you see Government playing? Mainly in a research area?

Mr. **Byrer**. Well, nearly all of this work was done with our own internal funds. Actually, starting back in 1969 we had some people who felt that eventually we were going to have to come up with a product that could degrade, and it has waited for its time and it seems like the time has come.

This material, as well as, I think, a lot of other materials—you certainly in your space explorations relied upon material properties being valid and reproducible—are part of the trend today to invent new materials and immediately talk about putting them on the marketplace. Superconductivity is a good example. We are going to make it today and it is going to run trains tomorrow. Composites are another example. Along the way, there has to be testing and evaluation data that says to a designer, if I go back tomorrow or the next day or the next day and want to use this material, it will have reliable, reproducible properties.

So what you see around this table, I think, and from some of the prior people who testified, the competitive marketplace is already beginning to take over in coming up with products that will in one way or another perhaps compete with each other. The one place where they all run aground is in having a reliable testing mechanism and one that also responds quickly.

We are talking about the products that we will find some applications in the fast food industry where the food is really in contact with it for a couple of minutes at the most, yet those products will have to go through FDA testing before they are ever allowed to be put into the marketplace. Sometimes that takes an extremely long time and any industrial company that is looking at getting a jump on other competitors in the United States or outside the United States is going to take a hard look at how long is it going to take to get this stuff approved if it is in any way at all likely to come in contact with food products.

I am convinced that we can sell this technology today in Japan and get it developed. We are talking about probably a 2-year program to get it up to where we are ready to start making product. I have resisted taking it to Japan and sell it because I am really trying to keep it as a viable product for U.S. industry.

So accelerating the ability to test all of these products I think is, at least in the near term, certainly a key role that the Government can play in this.

Chairman GLENN. Thank you. Mr. Hanik?

Mr. HANIK. Senator Glenn, I was very encouraged to hear your support for end-use applications for agricultural products. I think that addresses the supply/demand situation, which is the best way to approach improving the economic situation in the agricultural industry.

Everyone has mentioned testing, and I will not go over that again except to comment that in our industry we have always defined the needs in functional terms. Customers rarely say that they need polyethylene or polypropylene. Instead, they say they need a certain tensile strength and impact strength and stress crack resistance and so forth.

If we define biodegradability in the same way, then industry will develop those products which are most economically well suited and those will be the ones that are used. I believe that corn starch based products will have a segment of that market because they will be the economically advantageous product in many areas.

I also mentioned recycling, and we would like to see a lot more done in recycling. We are very enthusiastic about this. If you look at the whole system for solid waste management, what happens is that today we extract hydrocarbons, petroleum, natural gas out of the ground and we either burn them or we turn them into plastic products and then dispose of them.

A better method would be to take them out of the ground, make plastic products out of them, recycle those products as much as we can, and then incinerate them and recover a good portion of the heat value that we would have got if we had just burned them directly. So we would like to see the Government get more involved, particularly in the recycling area, and encouragement of recycling programs at the local level in the communities.

The little bit of looking into this we have done, I think we see great enthusiasm in the public for recycling programs and in Europe they have been very successful in terms of segregating plastics from the solid waste stream. So I think that would be a very appropriate area for Government to operate in.

Chairman GLENN. Mr. Makrauer.

Mr. MAKRAUER. In addition to endorsing the comments that have been made about the establishment of standards and test methods and definitions of degradability, as have been mentioned, I see two other roles for the Federal Government in this issue. One is the stimulation of individual special projects that can test the practicality of what some of the initial proposed solutions are.

For example, we have received an inquiry from the Department of the Interior with regard to the applicability of degradable bags in a special application that they have as opposed to a general full line conversion from nondegradable to degradable packaging. So we are exploring that particular application which might in fact be a genuinely good application for degradable packaging.

A second area of responsibility has to do with the coordination of the efforts—and this again gets back to some of the research—but coordination of some of the activities by leading in its own activities that are taking place with municipal, county and State governments right now on these same issues. I would compare the situation that exists on the issue and within the industry today with what took place with the enactment of the Clean Air Act. When that was enacted at the Federal level, at least there was—in spite of what industry might have viewed it to be as an onerous challenge—there were uniformly understood standards that had to be met. Those were defined by the Federal Government which then imposed them on the State governments and then the county governments.

The complete opposite is taking place today on the issue of solid waste management and the degradability of plastics. Laws and regulations are being promulgated at the municipal, county and State level without any coordination, without any exchange of communication on these topics. And if there was some unanimity as to what the objectives were, what the problems were, what the definitions were, I think that perhaps that could be the greatest contribution of the Federal Government in this issue.

Chairman GLENN. Let me ask you, you are making money with these products now, right?

Mr. MAKRAUER. I hope so.

Chairman GLENN. Are you using these as a loss leader? Are you competitive in your pricing on these? Or are these a premium product that goes above the normal pricing? I am getting into your business details here, but I mean to.

Mr. MAKRAUER. That is okay. Yes and no to a lot of those questions. If we were to look at the total monies and efforts we have put into the degradable packaging program since we started developing it in the summer of 1987, it has not been a profitable operation for us yet. There has been a tremendous amount of money put forth on production runs—not lab runs but full-scale production runs—to see what exactly happens with different levels of loading, the strength of bags and so forth.

The current—assuming we consider all of that cost behind us—we are pricing those bags today at what we hope are profitable price levels.

Chairman GLENN. Are you competitive?

Mr. MAKRAUER. The pricing is higher than the nondegradable bag of the same size, gauge and construction because the cost of the degradable additive adds a substantial component to the cost at this point.

Chairman GLENN. Ten to 15 percent? Something like that? That is a figure we have heard.

Mr. MAKRAUER. We are within that range, yes. We are finding that--depending on the style and construction of the bag—anywhere from about 8 percent up to 18 percent. But that is also as a result of the fact that we are guided by the recommendations of the corn starch degradable additive suppliers who are telling us that for our product to perform, according to their test data, we should be including 6 percent corn starch in the finished product.

Again, I want to get back to the point made earlier about the contention of the supplier who said that on today's technology they thought they could produce a product that was very, very close, depending upon the rate or extent of degradation required by the Act. This points out one of the biggest problems I see with respect to the expectations of customers and those who are concerned about degradation.

Since the degradable additive adds such an important component to the cost of the product and at a cost premium today, it is important to establish standards all of us as producers can attain uniformly so we are not misleading or disappointing anybody.

Chairman GLENN. Mr. Galvin, the time at which PHBV items become commercially viable may depend in part of the world price of petroleum, obviously. Has ICI done any studies indicating what the world price of oil would have to be in order for PHBV to become the plastic material of choice, I guess we could call it?

We would assume that you are in large scale production here so that you do not have a lot of extra start-up costs or something. But do you know what the world price of oil would have to be to allow you to start moving?

Mr. GALVIN. I apologize, but I do not have a fixed number for that and I would not want to lead you astray. But the way we see it is that with the agricultural surpluses as they are, that eventually we are going to get there.

What we do right now, we use approximately the equivalent of 5 pounds of corn starch for every pound of plastics. So if you consider that the corn starch has to first be converted into corn syrup, which upgrades the price a little bit, we are going to be talking about something that is going to be below 50 cents a pound for raw material.

Then we have to get our act in order to get the process correct so we get the appropriate molecular weights and strengths and everything else that Pete was referring to that meet the application. That is our job. But eventually petroleum is going to be more than 50 cents a pound.

Chairman GLENN. Mr. Byrer, you have a big economic section at Battelle. Have you ever tasked them to price that out as to where we would be ahead to move into some of these other areas based on the world price of oil and what that price would be?

Mr. BYRER. Not specifically. We have done some looking at the price of this material, recognizing that it could be made either from petrochemical or corn as a feed stock, and some of the companies that we have been talking to have asked us the same question, but we have not really looked at a comparative number at this point.

Mr. GALVIN. I would say further, Senator, that—and I think George can back this up—but the price of polyethylene, for example, has doubled, roughly, over the past 18 months.

Chairman GLENN. We may be getting there fast.

Mr. MAKRAUER. Well, when I heard the price of 50 cents a pound I was thinking I would give you an order this afternoon for it. [Laughter.]

Mr. GALVIN. I said raw materials.

Chairman GLENN. I am glad to have provided a role in bringing you people together here.

We are going to have to end. We have our caucus meetings here at noon on Tuesday, on both sides of the aisle, so we are going to have to end right now.

This has been very interesting this morning. I do not want anybody to think for a moment that this legislation is something that we think has all the answers to these problems. It does not by a long shot. But as I said several times over here, we are just concerned that we are not still testing and still developing and still doing all of these other things when we are then buying the product from some other country.

So we are interested in taking this as sort of a test case and seeing if we cannot move it along by Government purchasing through GSA.

Meanwhile, I agree with everything that anybody has said this morning about safety and setting standards and making sure we do this in the right way, and that to me it seems is a role that Government has to provide. I do not think any one group or industrial group can do that for us. That has to come from the Government, and so that is an area we obviously have to get going on and do a lot of work on as fast as we possible can.

But you gentlemen are out there sort of in the forefront of what I see as really the cutting edge of a whole new breakthrough in this area, what we can do with agricultural products. We are just in the infancy in this area and I think all of you agree with that.

This has been an interesting hearing this morning, thank you very much for being here. The hearing will stand in recess subject to the call of the Chair.

[Whereupon, at 12:35 p.m., the hearing was recessed subject to the call of the Chair.]

APPENDIX

II

100TH CONGRESS
2D SESSION

S. 2298

To require the Administrator of the General Services Administration to encourage the development and use of plastics derived from certain commodities, and to include such products in the General Services Administration inventory for supply to Federal agencies, and for other purposes.

IN THE SENATE OF THE UNITED STATES

APRIL 20 (legislative day, APRIL 11), 1988

Mr. GLENN introduced the following bill; which was read twice and referred to the Committee on Governmental Affairs

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A BILL

To require the Administrator of the General Services Administration to encourage the development and use of plastics derived from certain commodities, and to include such products in the General Services Administration inventory for supply to Federal agencies, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Agricultural Commodity-Based Plastics Development Act of 1988".

SEC. 2. FINDINGS AND PURPOSE.

(a) FINDINGS.—Congress finds that—

(1) the achievement of long-term health for the agriculture sector of the United States is essential to the vitality of the national economy, the well-being of our citizens and rural communities, and the maintenance of national security;

(2) the development of new non-food uses for agricultural commodities will reduce crop surpluses, raise farm income, and lower the cost of agricultural subsidies provided by the Federal government;

(3) the economic security of the United States requires that the Federal government should promote the development and use of products derived from agricultural commodities through the preferential procurement of such products to reach a threshold level of commercial application at which such products can successfully compete;

(4) more than ½ of the cities in the United States will exhaust their current landfill capacity by 1990, and the management of this growing volume of solid waste is one of the most urgent and fundamental environmental problems facing Federal, State, and local officials;

(5) plastic products comprise a significant amount of the 150,000,000 tons of solid waste produced in the United States and the use of degradable plastics prod-

ucts made from agricultural commodities can provide a positive impact in solving the problem of solid waste disposal;

(6) the technology exists to develop and market degradable agricultural commodity-based plastics for use in packaging, agricultural mulching, and in other applications;

(7) the widespread introduction of the technology referred to in paragraph (6) into the commercial marketplace will provide a new outlet for United States agricultural products;

(8) the use of domestically produced agricultural commodity-based degradable plastics products will reduce the reliance of the United States on imported oil and result in an improved trade balance for the United States and increased employment opportunities for our citizens; and

(9) the Federal government should assist in bringing agricultural commodity-based degradable plastics to a level of commercial application comparable to other alternative products and should provide incentives for the development and adoption of such products.

(b) PURPOSE.—It is the purpose of this Act to provide—

(1) that the Federal Government shall—

(A) promote the continued development of degradable plastics technology by increasing the purchases of degradable plastics products, with special emphasis on agricultural commodity-based products;

(B) assist State and local entities in purchasing degradable plastics products;

(C) provide incentives for further technology development through the preferential procurement of degradable plastics products, with special emphasis on agricultural commodity-based technologies;

(D) promote the manufacture and purchase of degradable plastics products by assisting producers in demonstrating the capability of this technology;

(E) increase the commercial availability of agricultural commodity-based degradable plastics products;

(F) support existing Federal, State, local, and privately sponsored degradable plastics programs; and

(G) be provided with advice concerning the status of research in new non-food uses for agricultural commodities; and

(2) for the establishment of an interagency working group to develop and coordinate the implementation of this Act.

SEC. 3. DEFINITIONS.

As used in this Act:

(1) Agricultural commodity-based plastics.—The term "agricultural commodity-based plastics" means plastic products that use agricultural commodity products as a constituent component.

(2) Degradable.—The term "degradable" means the biologically or light induced loss of utilitarian or physical characteristics of a plastic or hybrid material containing plastics as a major component.

(3) Government purchasing catalogue.—The term "government purchasing catalogue" means any approved list of items supplied by the General Services Administration to agencies of the Federal government.

(4) Non-food uses for agricultural commodities.—The term "non-food uses for agricultural commodities" means uses for agricultural commodities that do not involve the consumption of the commodities as food.

(5) Preferential procurement.—The term "preferential procurement" means any procurement

practice employed by the Federal government that gives preference to the selection of an item or service based on any criteria in addition to cost and performance.

(6) SLIDING SCALE RATING METHOD.—The term "sliding scale rating method" means an evaluation method used in Federal procurement procedures that reduces the cost bid for an item according to an established criteria for purposes of determining the effective low bid.

(7) SOLID WASTE.—The term "solid waste" means non-sewage waste which must be disposed of by Federal, State, or local officials through landfills, incineration, or other approved methods.

SEC. 4. ENCOURAGEMENT OF DEVELOPMENT AND USE OF COMMODITY-BASED PLASTICS.

(a) GENERAL SERVICES ADMINISTRATION.—The Administrator of the General Services Administration (hereinafter referred to in this Act as the "Administrator") shall—

(1) identify products in the General Services Administration government purchasing catalogue or in the inventory of the General Services Administration that can be made from degradable plastics technology, and that are environmentally safe, with particular emphasis on agricultural commodity-based products; and

(2) make available in the standard General Services Administration government purchasing catalogue the products identified above through competitive bidding process as prescribed in subsection (c).

(b) REQUESTS.—On the request of the head of any agency of the Federal government, the Administrator shall ensure that such Federal agency be provided with products acquired under this section to the maximum extent practicable.

(c) COMPETITIVE BIDDING.—

(1) SLIDING SCALE.—In awarding competitive bids for the provision of products, the Administrator shall develop and implement a sliding scale rating method for awarding contracts based on such competitive bids for the acquisition of products under subsection (a).

(2) FACTORS.—The sliding scale developed under paragraph (1) shall consider, in addition to price and performance of the offered products, other factors that make the use of degradable plastics technology advantageous, including—

(A) the increased market for agricultural products;

(B) the benefits to the environment; and

(C) the benefits to the long-term energy independence of the United States.

(d) COST OF PRODUCT.—

(1) IN GENERAL.—Funds appropriated under this section for the acquisition by Federal agencies of products under subsection (a) shall be applicable only to that portion of the cost of the product acquired under such subsection that exceeds the cost of comparable conventional products.

(2) COST TO AGENCY.—The Administrator shall ensure that the cost to any Federal agency receiving products under this section shall not exceed the cost to such agency of a comparable conventional product.

(e) INELIGIBILITY.—Federal agencies are ineligible to receive funds under this section for reimbursement of costs to buy products that such agency is required by law to purchase.

(f) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated to carry out this section, $20,000,000 for each of fiscal years 1989 through 1991 to pay for the difference in costs between conventional products and degradable plastic products.

SEC. 5. INTERAGENCY WORKING GROUP.

(a) ESTABLISHMENT.—The Administrator shall establish an interagency working group to coordinate activities under this Act and to encourage the use and development of agricultural commodity-based plastics.

(b) MEMBERS.—The group established under subsection (a) shall include—

(1) the Administrator of the General Services Administration;

(2) the Secretary of Agriculture;

(3) the Secretary of the Navy;

(4) the Secretary of Defense;

(5) the Administrator of the Environmental Protection Agency;

(6) the Secretary of Health and Human Services;

(7) the Administrator of the Food and Drug Administration;

(8) the Administrator of the Veterans' Administration;

(9) the Director of the Fish and Wildlife Service;

(10) the Commandant of the Coast Guard; and

(11) the heads of all other Federal departments and agencies engaged in research, investigation, or studies involved with plastics pollution and the need to develop biodegradable plastics.

(c) PERSONNEL.—The detailing of personnel from any Federal agency to the interagency group shall be permitted.

(d) MEETINGS.—The interagency group shall meet within 90 days of the date of enactment of this Act, and shall meet a minimum of one time a year.

(e) REPORT.—

(1) IN GENERAL.—Not later than 120 days after the date of enactment of this Act, and annually each year thereafter, the interagency group shall prepare and submit, to the Committee on Government Operations of the House of Representatives and the Committee on Governmental Affairs of the Senate, a report that contains the information required in paragraph (2).

(2) CONTENTS.—The reports submitted under paragraph (1) shall contain—

(A) requests by the Administrator for appropriations and staff resources dedicated to implementing this Act;

(B) products identified in section 3 for inclusion in the inventory of the General Services Administration;

(C) numbers and types of products provided to government agencies under this Act; and

(D) statistics on the level of commercial involvement and development of such reports.

SEC. 6. REPORT ON NEW NON-FOOD USES FOR AGRICULTURAL COMMODITIES.

(a) IN GENERAL.—Not later than 90 days after the date of enactment of this Act, the Secretary of Agriculture shall prepare and submit, to the Committee on Agriculture of the House of Representatives and the Committee on Agriculture, Nutrition, and Forestry of the Senate, a report on the progress and status of the implementation of section 1436(b) of the Food Security Act of 1985 (7 U.S.C. 1632), concerning research into new non-food uses for agricultural commodities.

(b) CONTENTS.—The report prepared under subsection (a) shall include information concerning—

(1) executive department requests for appropriations used to carry out such section;

(2) staff resources dedicated to implementing the section referred to in subsection (a);

(3) grants awarded under such section; and

(4) other related activities by the Secretary concerning research into new non-food uses for agricultural commodities.

United States General Accounting Office

GAO

Testimony

For Release
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1988

Degradable Plastics: Standards, Research and Development

Statement of
Flora H. Milans, Associate Director
Resources, Community and Economic
Development Division

Before the
Committee on Governmental Affairs
United States Senate

Mr. Chairman and Members of the Committee:

We are pleased to be here to discuss our report on degradable plastics, which was requested by this committee and which is being issued today. As requested, our report (1) identifies the extent of federal and private sector efforts to develop standards for degradable plastics and (2) describes federal agencies' support of degradable plastics R&D.

Overall, we found that only limited federal and private sector ~~effort~~s are being made to develop standards for degradable plastics. There is a growing interest in commercializing degradable plastics. With this has come a general recognition by scientists and management officials in both government and industry that standards for degradable plastics need to be developed before their widespread use can occur. Such standards would include uniform definitions and methods of testing to evaluate product performance. They would help assure consumers of a satisfactory product and facilitate manufacturers' compliance with existing and potential legislation mandating the use of degradable plastics.

We also found that federal agencies' support of degradable plastics R&D has been limited. Federal expenditures total $1.7 million for 12 projects in fiscal year 1988 and emphasize the development of new degradable plastic materials rather than standards development. These projects include very basic research and applied R&D intended for specific uses. The federal agencies supporting these activities, however, are not among those that would be most appropriate to develop standards. In addition, virtually no testing of degradable plastics to determine degradability and safety of the end products in different environments has occurred; what limited testing is planned or being conducted may help to evaluate degradability and safety but does not in itself ensure the establishment of needed standards.

BACKGROUND

Before discussing these matters further, I'd like to provide some background information. The mounting problems posed by the permanency of plastics in municipal solid waste, litter, and marine pollution have led to a search for solutions, including the use of degradable plastics. Unlike traditional plastics, which may persist in the environment for centuries, degradable plastics are intended to disintegrate in a matter of months through degradation by sunlight (photodegradation) or microorganisms (biodegradation). They thus may be able to reduce the life span of litter in the landscape and at sea; they may also diminish the amount of plastics accumulating at landfills. In addition to their potential environmental benefits, degradable plastics offer new opportunities for the use of agricultural commodities instead of petroleum in the manufacture of plastics. Cornstarch in particular is a leading ingredient.

THE NEED FOR STANDARDS REGARDING DEGRADABLE PLASTICS

Widespread concern exists among federal and private sector officials and scientists about the current lack of standards. Definitions of such basic terms as photo- and biodegradation have not yet been agreed upon, nor have uniform methods of testing been developed. The director of the plastics department at Dow Chemical USA described the overall situation of degradable plastics as "a state of chaos." A scientist conducting federally sponsored research on degradable plastics at the Massachusetts Institute of Technology described the problem as follows: "Most of the biodegradability studies are very ill-defined, not quantitative and not standardized as to what is biodegradable. The community in this area has not reached satisfactory standards or procedures allowing for uniform comparison of biodegradability. There is a need for further development of policies and procedures for this critically important area."

In developing standards, two important technical uncertainties associated with degradable plastics remain to be addressed: the rate of degradation and the safety of the end products. Issues relating to the rate of degradation include the possibility that degradation may occur before the product has served its purpose or that it may occur too slowly to provide an effective solution to environmental problems. Safety-related issues include the potential toxicity of chemicals leaching from degradable plastics and the size of the plastic fragments resulting from degradation, which may pose a threat to wildlife or compound the litter problem.

Standards, according to various officials in the federal and private sectors, are needed as a basis for effective legislation. Officials are concerned that the current lack of standards may lead to unenforceable or confusing laws. Current legislation in 16 states requiring the use of degradable plastics for six-pack beverage container yokes tends to corroborate this concern. Laws in 9 of these states provide no definition of degradability; 10 states specify no time frame for degradability; and 11 states provide no requirements regarding the safety of the end products. The definitions, when provided, refer mainly to general processes, including photo- and biodegradation, while giving no further details. Time frames, when specified, vary between 120 days in Florida and 5 years in Minnesota. Of the 5 states with end product safety requirements, only 2 states require that both the particle size and chemical composition of degradable plastic fragments be established as safe but neither provide criteria for judging safety.

Federal Activities to Develop Standards for Degradable Plastics Are Limited

There are 3 primary government agencies with the capability to test and develop standards for new materials and products--the Environmental Protection Agency, National Institute of Standards and Technology (formerly called the National Bureau of Standards), and Food and Drug Administration. These agencies reported few or no activities involving degradable plastics. Each of these agencies is discussed briefly in the following material.

EPA's Activities

EPA's Office of Research and Development contains at least 4 laboratories capable of conducting needed tests, but none is currently underway. A senior EPA official told us that testing degradation rates and end product safety would be consistent with EPA's previous work. He indicated that such a task would be relatively easy to perform and could be conducted in either a cursory or a very thorough manner, as necessary.

Several of EPA's laboratories described their ability to address the technical uncertainties. The Gulf Breeze Laboratory (Gulf Breeze, Florida) would be able to evaluate the biodegradation of plastics. The Environmental Research Laboratory (Athens, Georgia) could address both bio- and photodegradation. The Robert S. Kerr Environmental Research Laboratory (Ada, Oklahoma) conducts research on the mechanisms and rates of degradation of chemicals in groundwater and could apply this expertise to degradable plastics in general. A fourth EPA laboratory, the Risk Reduction Engineering Laboratory (Cincinnati, Ohio), conducts a program involving the biodegradation of hazardous wastes. In fact, it has evaluated various plastics, including samples used in food packaging, for their biodegradability. This evaluation, however, occurred almost 20 years ago in the early 1970s, and the laboratory has performed no subsequent work in this area.

EPA is currently conducting a study on methods to reduce plastics pollution, as mandated by the Marine Plastics Pollution Research and Control Act of 1987. As part of its study, EPA is required to investigate the feasibility of making articles from degradable plastics, taking into account the rate of degradation and safety of the end products. However, EPA is planning no involvement by its laboratories in this assessment. Instead, it plans to review relevant technical literature and monitor certain private sector efforts to develop definitions and methods of testing for degradable plastics.

EPA officials said that, although the laboratories possess the capability, no tests of degradable plastics are currently underway because of other research and testing priorities. As a result, they expect that any future effort involving degradable plastics would probably be limited. An EPA official directing the development of new methods of testing for other chemicals told us that the responsibility for progress toward standardization resides with the private sector, unless the federal government mandates the use of degradable plastics and the standards they must meet. At that point, according to this official, EPA would have to become more involved in activities relating to standards development.

NIST's Activities

The Polymers Division within the National Institute of Standards and Technology, has about 40 scientists with expertise in plastics. It is planning to undertake one very small-scale project to test degradable plastics. A scientist in this division has requested samples and is planning a limited amount of testing. He will bury starch-based degradable plastics in soil and expose them to selected strains of microorganisms.

According to a senior official within the Polymers Division, one of three developments would have to occur for NIST to expand its testing: (1) the designation of a lead agency for degradable plastics and that agency providing funding to NIST, (2) an internal budget initiative from NIST, or (3) a congressional mandate. The Chief of the program office said that no determination has yet been made whether NIST would undertake an expanded degradable plastics program. However, she added that, since NIST receives more than 40 percent of its funding from other agencies, it might be able to obtain funding elsewhere to support an effort in this area.

FDA's Activities

The Food and Drug Administration has not approved any materials that are intended to increase the degradability of plastic food-packaging. However, the agency has recently been contacted by, and is working with, companies that are interested in food-packaging uses of degradable plastics. A senior agency official told us that FDA's assessment of food safety includes concerns about the shelf life of degradable packaging and potential food contamination. The agency also has responsibilities for assessing the environmental impacts of degradable plastics; its evaluation in this area would focus on the issues already mentioned, the time frame for degradability and the safety of the end products. FDA places the burden of proof for the safety and functionality of a new product as well as the analysis of environmental impact on the manufacturer. The agency will determine the extent to which FDA resources are needed to help develop testing methods for predicting the environmental impact of degrading plastics.

Private Sector Activities to Develop Standards for Degradable Plastics Are Limited

Private sector activities to develop standards for degradable plastics are being planned primarily through the American Society for Testing and Materials (ASTM). These activities are limited and their eventual contribution to standards development is difficult to evaluate at present.

ASTM is a scientific and technical organization that develops standards on the characteristics and performance of materials and products. It describes itself as the world's largest source of voluntary consensus standards. One of its numerous technical committees, known as the D-20 Committee on the Permanence Properties of Plastics, is chiefly responsible for ASTM's recent efforts to develop standards for degradable plastics. The subject was introduced for the first time at a committee meeting in March 1988. Members have agreed that they would like to develop a set of standards and methods for testing that would conform with ASTM's criteria. Two officials were appointed at the March meeting to work on definitions, standards, and methods of testing.

The official responsible for definitions is focusing on five principal terms, including biodegradability and photodegradability. The official concerned with standards and methods of testing sent a letter to about 40 companies and individuals inquiring whether they have or are aware of any standards relating to degradable plastics. He found no relevant standards but wanted to establish this fact as a starting point for further ASTM efforts.

ASTM provides a peer review process through which new methods of testing can be suggested, made known to other scientists, and evaluated for effectiveness. A plastics industry spokesperson believes that scientists need to identify specific conditions (such as landfills and marine environments) to be replicated for degradable plastics testing; he would like to see a variety of methods developed and subjected to ASTM review.

In summary, officials in the private and federal sectors recognize the need for degradable plastics standards, but relatively little effort to achieve this objective soon is underway. EPA, NIST, and FDA report few or no activities in this regard. ASTM's efforts are just getting underway and their outcome is uncertain.

FEDERALLY FUNDED R&D FOR DEGRADABLE PLASTICS

In addition to studying the need for standards, we identified the federally funded projects involving degradable plastics. We found that four agencies are conducting or supporting basic or applied research related to degradability of plastics and product development. The Departments of Agriculture (USDA), Defense (DOD) Energy (DOE), and the National Science Foundation (NSF) are supporting 12 R&D projects at a total funding level of $1.7 million in FY 1988. These projects are focused mainly on developing and improving new degradable products rather than addressing the need for standards regarding degradable plastics.

USDA is spending $941,000 on 4 projects for degradable plastics research aimed at developing new nonfood, nonfuel uses for agricultural commodities, particularly corn. The focal point for USDA's activities is the Northern Regional Research Center in Peoria, Illinois, where two projects involving degradable plastic films and molded products are funded at a total of $900,000. Two much smaller projects at universities are exploring the degradation rates of agricultural mulching films. The extensive use of plastic mulching films in agriculture and the high cost of their removal from fields have led USDA to evaluate degradable plastics for this purpose.

DOD's R&D program, accounting for $575,000, is focusing on alternatives to nondegradable plastics primarily for use at sea. Most of DOD's activities are concentrated on the use of microorganisms to produce degradable plastics. Two Navy projects and an Army project are experimenting with selected strains of bacteria and fungi capable of producing a variety of these biodegradable plastic materials. Practical applications are probably several years away; potential uses include degradable food packaging. An additional Navy project is exploring the use of cornstarch in a biodegradable plastic trash bag.

DOE has provided $150,000 to the Solar Energy Research Institute of Golden, Colorado to work with wood- and starch-based substitutes for petroleum-based plastics. The institute has awarded three subcontracts to explore innovative, inexpensive, lightweight materials. One of the subcontracted projects should increase the amount of degradable material in the finished product. Currently finished products can usually include no more than 6 to 10 percent of the degradable material. Products that have attempted to include a higher percentage have lost a proportionate amount of durability. The DOE project has boosted the percentage of degradable materials to levels as high as 25 to 35 percent with no loss of strength. NSF is also supporting this project with a $63,000 grant.

Scientists conducting federally funded R&D recognize the technical uncertainties associated with degradable plastics and the need for standardization. As a result, a few have begun to incorporate testing in their R&D; others are planning tests within the next year. This testing, as mentioned earlier, may help to evaluate product performance but does not in itself ensure the development of appropriate standards for degradable plastics.

OTA's Study of Municipal Solid Wastes and Plastics

We coordinated our work with the Office of Technology Assessment, which began a study of municipal solid wastes in late 1987 and is due to report to Congress in March 1989. OTA's study is focusing on the federal role in municipal solid waste management, including opportunities for waste reduction and recycling and for making incineration and landfilling safer. Efforts to promote the use of degradable plastics, according to an OTA official, should take into account their effectiveness in reducing solid waste and their compatibility with alternative approaches.

MATTER FOR CONSIDERATION BY THE CONGRESS

If the Congress wishes to promote degradable plastics, it may want to consider the following approach: select an agency (or agencies) which, in cooperation with the private sector, would undertake the development of standards, including uniform definitions and methods of testing. EPA and NIST would be appropriate agencies for such activities because of their extensive experience in testing for environmental effects and product performance.

This concludes my statement, Mr. Chairman. I would be happy to answer any questions that you or other Committee Members might have.

STATEMENT OF
JAMES L. DePROSPERO, JR.
ASSISTANT COMMISSIONER FOR COMMODITY MANAGEMENT
FEDERAL SUPPLY SERVICE
GENERAL SERVICES ADMINISTRATION

Mr. Chairman, I am James L. DeProspero, Assistant Commissioner for Commodity Management, Federal Supply Service, General Services Administration. Mr. John Alderson has asked that I represent him before you today to provide GSA's views on S. 2298, a Bill requiring that the Administrator of General Services:

- Identify products in the GSA purchasing catalog that can be made from degradable plastics technology, and that are environmentally safe, with particular emphasis on agricultural commodity-based products; and

- Make these products available to the Federal Government through the competitive bidding process.

I am accompanied today by William Gormley, my Deputy.

GSA is sympathetic to the intent of S. 2298 but opposes enactment of S.2298 at this time. We appreciate the importance of maintaining a strong agricultural base; the necessity for reducing the United States' reliance on imported petroleum products; and the requirement for controlling the ever-expanding solid waste problem in our environment.

We believe, however, that a procurement program which promotes the use of degradable plastic products can, if one is needed, be implemented satisfactorily within the Federal Government under existing statutory authority. However, there are several key questions that must be addressed and answered before GSA can undertake such a program. Among these concerns are:

- The extent to which the industry can respond to such a program and produce the products necessary to meet the Government's requirements;
- The timeframe necessary for degradable plastics to become competitive with comparable conventional plastic products.
- Whether a preference buying program would be sufficient incentive for commercial marketing and whether such a program would be practical, feasible, or desirable.
- Whether the Bill conforms fully with Federal Acquisition Regulations, including the Competition in Contracting Act (CICA)--particularly if nondegradable plastic products were precluded from competition.

- Whether the human and monetary resources necessary for implementing the large-scale requirements of the Bill are readily available within the Federal Government.

- Whether the ability of small business to compete in GSA procurements would be affected, since such business might be unable to obtain finances necessary to accomplish the product changes envisioned by this Bill. In addition, the preferential treatment for such products could cause them to obtain fewer awards under GSA procurements.

Consequently, we concur in the assessment of the Environmental Protection Agency (EPA) that enactment of this legislation at this time would be premature. In addition, as noted previously, we believe that adequate statutory authority already exists to undertake a program to promote the use of degradable plastic products.

You recently asked that we comment specifically on the feasibility of a preferential procurement program for degradable plastic products as well as give an economic assessment of such a program.

Regarding feasibility, we believe that a preferential program could be developed but we do not yet know the extent to which the research and development has progressed nor do we know the state of the industry regarding degradable plastics.

An economic assessment of this kind of program is equally as difficult to address. Although we have read that in some cases the basic degradable material used to produce products is 15% to 25% more costly than regular plastic materials, we have no information on how this translates to the cost of the end items. Will new equipment be required? Will it be specialized for degradable materials? Do any companies have production capabilities? Is there competition?

You further requested certain data on products in the GSA supply system that could be made of agricultural based plastics. Using the categories of products listed in the proposed bill, we have developed a list of all the items in the supply system in those categories. Along with the raw listing, we have included an explanation of the Codes in the column headed "AAC" (Acquisition Advice Codes) and copies of a number of pages from our supply catalog to help you identify some of the items in the listing.

We are providing this information with certain caveats that should be noted:

- We do not claim that any of these items will perform satisfactorily when made from agricultural based degradable plastics. That is something we do not know at this time.
- The listing demonstrates the wide variety of types, styles and sizes of products that we find in just one category of items. This points out the importance of the interagency working group to the ultimate success of a procurement program.
- The large number of items in the few categories shown emphasizes the need to address this important program with a procurement so as not to overwhelm the industry or our procurement offices.
- Finally, the cushioning material is not in the supply catalog. However, while you will not be able to readily indentify each item, the number of different items will be apparent and the individual yearly sales are shown.

Mr. Chairman, this concludes my prepared statement on S. 2298. GSA appreciates your providing us the opportunity to present our views on this bill.

We are submitting this statement with attachments for the record.

Mr. Gormley and I will be pleased to respond to any questions which Committee members may have on this subject.

57 x 48 x 21". 40 to box.
0.004" ......BX...... 8105-00-145-0163

Flat. Heat-seal closure.

3 x 5"
0.004" ......HD...... 8105-00-579-9286

4 x 6"
0.004" ......HD...... 8105-00-680-0503

5 x 12"
0.0015" ......HD...... 8105-00-702-7177

6 x 9"
0.004" ......HD...... 8105-00-579-9285

18 x 48"
0.0015" ......HD...... 8105-00-702-7178

20 x 40". 10 to package.
0.006" ......PG...... 8105-00-299-8532

24 x 24". 50 to package.
0.004" ......PG...... 8105-00-200-0195

24 x 35"
0.0015" ......HD...... 8105-00-702-7175

30 x 30"
0.003" ......HD...... 8105-00-070-9496

30 x 72"
0.004" ......EA...... 8105-00-060-8961

36 x 54". 50 to box.
0.003" ......BX...... 8105-01-033-1496

38 x 65". 50 to box.
0.004" ......BX...... 8105-00-759-0794

Flat. Wire tie closure.

6 x 9"
0.004" ......HD...... 8105-00-660-0603

9 x 12"
0.004" ......HD...... 8105-00-159-4998

10 x 15". 50 to box.
0.0015" ......BX...... 8105-00-149-0309

Black. Perforated. Wire tires included. 0.002" thick. 50 to roll. 200 (4 rolls) to box.
30 x 40" ......BX...... 8105-00-989-2376

36 x 38"
0.001" ......HD...... 8105-00-579-8451

36 x 54". 50 to box.
0.005" ......BX...... 8105-00-848-9631

Flat. Interlocking seal closure. Thickness 0.004".

1,000 to box.
4 x 4" ......MX...... 8105-00-837-7753
6 x 6" ......MX...... 8105-00-837-7754
8 x 8" ......MX...... 8105-00-837-7755

500 to box.
10 x 10" ......BX...... 8105-00-837-7756
12 x 12" ......BX...... 8105-00-837-7757

Duty Rating Conversion Chart

This chart converts low density polyethylene (LDPE) bag thickness, as given in this description, to duty rating which will provide equivalent bag performance. Due to advancing technology and new polymers, the bags will be slightly thinner, but will perform as well in service as LDPE bags of the listed thickness.

LDPE Bag Thickness (Inches)	Duty Rating Providing, Equivalent Performance
0.0015	Light
0.0015	Medium
0.002	Heavy
0.0025	Heavy
0.003	Extra Heavy
0.004	Extra Heavy

Flat style. Polyethylene single-wall. Heat-sealed. Use for packaging and disposal of garbage, refuse, or contaminated waste. Dimensions and colors shown. Technical Purchase Description (TPD) FCMM-8105-1.

Medium-duty

23 x 24". 10 gal. capacity. Red with inscription: "Danger Infectious Waste" in English and Spanish. With closure ties. 250 to box.
......BX...... 8105-01-151-1097

24 x 23". 7 gal. capacity. Any color except red or yellow. No closure ties. 250 to box. Replacement for 8105-00-655-8285.
......BX...... 8105-01-195-8730

30 x 36". 20 gal. capacity. Any color except red or yellow. No closure ties. 250 to box.
......BX...... 8105-01-183-9766

30½ x 41". 30 gal. capacity. Red with inscription: "Danger Infectious Waste" in English and Spanish. With closure ties. 250 to box.
......BX...... 8105-01-148-0280

Heavy-duty

20 x 21". 7 gal. capacity. Any color except red or yellow. No closure ties. 500 to box. Replacement for 8105-00-726-5592.
......BX...... 8105-01-184-7159

30 x 36". 30 gal. capacity. Any color except red or yellow. No closure ties. 250 to box. Replacement for 8105-00-726-5606.
......BX...... 8105-01-183-9767

33 x 39". 30 gal. capacity. Any color except red or yellow. No closure ties. 125 to box. Replacement for 8105-00-655-8286.
......BX...... 8105-01-183-9768

33 x 39". 30 gal. capcity. Dark brown or dark green. With closure ties. 125 to box. Replacement for 8105-00-989-2376.
......BX...... 8105-01-183-9769

36 x 58". 55 gal. capacity. Dark brown or dark green. With closure ties. 50 to box.
......BX...... 8105-01-183-9763

Extra Heavy-duty

24 x 23". 7 gal. capacity. Any color except red or yellow. No closure ties. 250 to box. Replacement for 8105-01-033-1497.
......BX...... 8105-01-183-9765

33 x 39". 30 gal. capacity. Dark brown or dark green. No closure ties. 125 to box. Replacement for 8105-01-033-1498.
......BX...... 8105-01-183-9770

36 x 58". 55 gal. capacity. Any color except red or yellow. No closure ties. 50 to box. Replacement for 8105-00-848-9631.
......BX...... 8105-01-183-9764

36 x 58". 55 gal. capacity. Dark brown or dark green. With closure ties. 50 to box. Replacement for 8105-01-033-1496.
......BX...... 8105-01-183-9762

Gusset style. Polyethylene, single-wall. Square. Heat-sealed. For packaging and disposal of refuse or contaminated waste. Dimensions are width, gusset, and length. Colors shown. TPD, FCMM-8105-1.

Light-duty

12 x 8 x 22". 7 gal. capacity. Clear. No closure ties. Fits VA small step-on can and NSN 7240-00-634-0001. 500 to box.
......BX...... 8105-00-330-7264

Extra Heavy-duty

17 x 15 x 44". 30 gal. capacity. Clear. With closure ties. Exception to FCCM-8105-1: Impact resistance (DART) shall be 165g min. Fits VA 25" hampers. 125 to box.
......BX...... 8105-01-150-6256

Bag, Sand

For use in the construction of field fortifications. MIL-B-12233.

Class A. Jute or kenaf burlap. 14 x 26".
......HD...... 8105-00-285-4744

Class B. Cotton osnaburg. 14 x 26".
......HD...... 8105-00-965-2509

Class C. Cotton canvas duck. For use in stabilizing the 4.2" mortar base. Tie string closure. 23½-29" long, 12½-15½" wide.
......EA...... 8105-00-782-2709

Bag, Textile

Legend: "U.S. Property, Nails." Cotton duck bag for storing nails on the job. Olive drab. 6" dia., 9" high. Drawstring closure. Mildew-resistant and water-repellent. MIL-B-43166.
......EA...... 8105-00-267-6000

Legend: "Emergency Runway Lights and Spares." Flat rectangular bottom. Slide closure and two carrying handles. Water-repellent. Yellow.

12 x 24 x 20"
......EA...... 8105-00-592-0515

Natural. Cotton duck. Synthetic resin external single wall. Drawstring closure. Mildew-resistant. 32" long, 17" wide.
......EA...... 8105-00-290-4579

Bag, Valuables

Olive drab cotton duck. 8.25-oz. per sq. yd. Water-repellent and mildew-resistant. Round bottom, 7⅛" dia., 12⅛" high. Drawstring closure. Unnumbered with unnumbered receipt tag. Marked "U.S." MIL-B-1977.
......EA...... 8105-00-933-1430

Envelope, Packaging

Corrugated fiberboard. Square cut. Flap closure. No. to box shown. Commercial Item Description (CID) A-A-286.

6½ x 10"
(500) ......BX...... 8105-00-959-2559

Item con. on next page.

Domestic. One-piece folder. Single wall. Flat assembly. Die cut and scored. Dupont Surlyn and resin compound treated. Flap closure with adhesive fasteners. Nom. inside dimensions shown. Bursting strength 200 p.s.i., grade 200. Naval Supply Systems Command P/D SUP #0321.1B

Size 10. 9 x 6 x 3". 50 to bundle.
BD 8115-00-467-2405

Size 20. 12 x 8 x 5". 50 to bundle.
BD 8115-00-501-5634

Size 30. 12 x 10 x 4". 50 to bundle.
BD 8115-00-467-2407

Size 60. 18 x 14 x 5". 25 to bundle.
BD 8115-00-507-6165

8 x 12 x 6". 25 to bundle.
BD 8115-00-467-2410

Double wall. Corrugated fiberboard. Half-slotted. Full telescopic. Domestic. Nom. inside dimensions—56 x 16 x 16". Detachable cover 11" deep. Flat form. Grade 500. Ten to bundle. For. Serv. Spec. 5100-50.
BD 8115-00-139-0690

Box, Storage

Steel repair part boxes. Use for the protection of on-board repair parts for both electrical and mechanical equipment stowed on ships. Gray enamel finish. 18 x 12 x 6" with hinged cover, hasp and staple for padlock and carrying handle on each end. Type M, MIL-B-233
EA 8115-00-030-2745

Box, Wood

Cleated

Plywood. Knocked-down. Size and outside dimensions shown. Type I, style 1, MIL-B-43666

29 x 31¾ x 20½" Size 9
EA 8115-00-935-6532

29 x 31¾ x 41" Size 4
EA 8115-00-935-6527

43 x 31¾ x 20½" Size 8.
EA 8115-00-935-6531

43 x 31¾ x 41" Size 3
EA 8115-00-935-6526

57 x 31¾ x 20½". Size 7.
EA 8115-00-935-6530

57 x 31¾ x 41" Size 2
EA 8115-00-935-6525

58 x 43 x 41" Size 5
EA 8115-00-935-6528

86 x 31¾ x 41" Size 1
EA 8115-00-935-5887

Plywood. Demountable. For worldwide shipping and storage of household goods. Outside dimensions: 96" long, 42" wide, 83⅝" high. Type 2, PPP-B-580
EA 8115-00-537-6681

Nailed

Lock-corner. For shipping average loads overseas. For place-packed articles, books, paper, cartons containing small hardware, glass bottles and china packed with wadding, and canned goods. Four plain cleats each end. 400-lb. load weight. Class 2, style 2, PPP-B-621.

37 x 10 x 14½"
EA 8115-00-685-5171

Wirebound

Plywood consolidation containers with pallet base. Integral type cover. Holds up to 1,500 lbs. Size 4. Type II, style 1, MIL-B-43666.

29 x 31¾ x 41"
EA 8115-00-935-6518

Box Set

Plywood nested set of four boxes, green enamel finish. For shipping and storing military organizational equipment. Two handles to box. Can be stacked open or closed to form shelving. Each holds up to 150 lbs. Box I: 36¾ x 20¾ x 17¾"; Box II: 34¾ x 19¼ x 16⅝"; Box III: 32¾ x 17¾ x 15⅛, Box IV: 30¾ x 16¼ x 14⅜. Type MG-1A, MIL-B-8111.
SE 8115-00-290-6016

Carton, Egg

Molded-pulp for one dozen eggs. 250 to bundle. Commercial Item Description (CID) A-A-689.
2 x 6 rows BD 8115-00-826-4106

Container, Plastic

Molded. For liquids, powders, and pastes. Contoured handle. PPP-C-569.

Low-density. Fiberboard overpack for easy stacking.
5-gal EA 8115-00-194-1653

High-density.
5-gal EA 8115-00-145-0038

Container Assembly, Sample and Specimen Shipping

Tin-plated, inner container. With screwcap and bridge type handle. Enclosed in folding fiberboard box, with corrugated top and bottom cushions. MIL-C-43391

12 x 5 x 7¼"
½-gal EA 8115-01-090-0660
1-gal EA 8115-00-224-7935

Container Set

Consists of foam cushioning, barrier material, box liner, and exterior container. Exterior dimensions: 28⅞" long, 18⅞" wide, 19" deep. Assembled with barrier material and bag folded in carton.
SE 8115-00-439-4302

Crate, Shipping

Natural wood inside and out. Domestic. Used for sign painting equipment. Reinforced slatted with solid ends. Wood screw assembly. Hinged cover, hasp fastening. Pull rings/tab handles. Reinforced with wood cleats. 3.1 cu. ft. capacity. Nom. inside dimensions—33½ x 14¼ x 11¼".
EA 8115-00-222-3715

Kit, Fuel Sampling

Durable, reusable. For transporting aviation fuel samples by ground or air transportation. Four sampling bottles, 32 oz. each in a kit. Assembled to use. Cushioning material, exterior container, and four sampling tags. MIL-K-23714.
EA 8115-00-719-4111

Replacement Kit, Fuel Sampling

Replacement for Kit, Fuel Sampling (8115-00-719-4111). Contains four disposable bottles, four caps, and four tags. MIL-K-23714.
EA 8115-00-717-8572

Class 8125

Bottle, Applicator

White plastic atomizer. "U.S. Government" marked in ¼" characters (letters). Plastic trigger type atomizer cap attached to bottle with flexible plastic tuba. Adjust spray by turning nozzle on cap. Commercial Item Description (CID) A-A-831
1-pt EA 8125-00-488-7952

Plastic spray. Oval. Hinged cap has spray opening and attached flexible tube. Commercial Item Description (CID) A-A-685.
8-oz EA 8125-00-782-4000

Bottle, Drinking Water Dispenser

Glass or plastic/polyethylene. Round. 5-gal. Commercial Item Description (CID) A-A-1232.
EA J8125-00-132-9566

Bottle, Screwcap

Nonbreakable, heat-resistant, plastic 1-oz water bottle. Screwcap. Component for Forest Service carrying case 8465-00-521-3057. L-B-560.
EA 8125-00-824-9058

Hot drink. Round. Type I.

Plastic-coated. Class 3, style A.

Tall. Without handle. Rolled edge.

8 oz., 2,000
BX 7350-00-290-0588
MX 7350-01-056-2896

12 oz., 1,000
BX 7350-00-641-4517

16-oz., 1,000
BX 7350-00-641-4576

Tall. Coverall lid and handle.

6 oz., 1,000
BX 7350-00-205-1182

8 oz., 1,000
BX 7350-00-988-6498

Without handle. Rolled edge.

8 oz., 2,000
BX 7350-00-162-3006

With coverall lid, without handle.
8 oz., 500 BX 7350-00-753-3182

Hot food. Round. Type II.

Uncoated, moisture resistant. Squat cup with rolled edge. Class 1, style A.

(169)

Cup only
8-oz., 1,000 BX 7350-00-641-4520
12-oz., 1,000 BX H7350-00-641-4518
16-oz., 500 BX 7350-00-290-0586

(169)

Cup with coverall lid
8 oz., 500 BX H7350-00-903-9201
12 oz., 1,000 BX H7350-00-903-9202

Waxed. Rolled edge. Class 2, style A.
Cup only
1 oz., 5,000 BX H7350-00-290-0589

Cold drink.

Round. Type III

Waxed. Class 2, style A.

(170)

Cup only
5 oz., 2,500 BX 7350-00-641-4587

6 oz., 2,500
BX 7350-00-281-3211

7 oz., 2,500
BX 7350-00-641-4589

(170)

8-oz., 2,500
BX 7350-00-641-4590

9-oz., 2,500
BX 7350-00-641-4593

10-oz., 2,500
BX 7350-00-641-4591

12-oz., 2,500
BX 7350-00-641-4592

16-oz., 1,000
BX 7350-00-641-4523

Cup and plastic coverall lid

6-oz., 1,000
BX 7350-00-903-8141

Tall cup and plastic coverall lid

10 oz., 1,000
BX 7350-00-903-8142

Squat cup and plastic coverall lid
16-oz., 500 BX 7350-00-903-8147

Cold food. Light-duty (ice cream, cream, or condiments). Round. Type IV.

Waxed. Class 2, style A.

Cup only

8-oz., 1,000
BX 7350-00-641-4621

Water cup. Type VI.

Uncoated round. Class 1, style A.

4-oz., 5,000
BX 7350-00-290-0578

Waxed round. Class 2, style A.

4-oz., 5,000
BX 7350-00-162-6212

Uncoated, pleated. Class 1, style B

(171)

3¼-oz., 5,000
BX 7350-00-290-0574

(171)

(172)

Uncoated, conical. Class 1, style C

Straight edge

3½-oz., 5,000
BX 7350-00-290-0584

(172)

Rolled edge

3¼-oz., 5,000
BX 7350-00-224-7702

(173)

Uncoated, flat, not nested. Class 1, style E.

4-oz., 10,000
BX 7350-00-290-0573

(173)

Portion cup. Type VII

Uncoated, pleated. Class 1, style B.

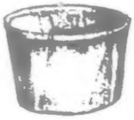
1-oz., 5,000
BX 7350-00-290-0580

(174)

BX 7350-00-817-0342

4-oz., 5,000
BX 7350-00-290-0582

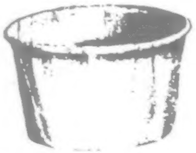
(174)



(175)

5½-oz., 5,000
BX 7350-00-290-0583

(175)



Hot food and drink

White, disposable. Round, rolled edge, flat base, plastic-coated. For hot liquids and solids. Without lid. ⅛" maroon band. 2,000 to box.

5-oz BX 7350-00-458-0089
7-oz BX 7350-00-456-2024

Cup, Plastic

One-time use molded polystyrene (no handle). Rounded drinking edge. Easy to stack. For hot or cold drinks. 1,000 to box, except 7350-00-145-6126 is 500 to box. L-C-770.

Item con. on next page.

.7350-Industrial

Extra insulation, up to 203° F. Type II.

Cup only.			
	6-oz	BX	7350-00-721-9003
	8-oz	BX	7350-00-082-5741
	10-oz	BX	7350-00-926-1661
	16-oz	BX	7350-00-145-6126
Cup with lid.			
	6-oz	BX	7350-00-761-7467
	8-oz	BX	7350-00-914-5089
	10-oz	BX	7350-00-914-5088

Dinnerware, China

Vitrified white china. For preparing, serving, and storing food. 36 to box except where noted. M-C-301

Maroon band with caduceus

Bowl, soup	12-oz	BX	7350-00-721-6000
Cup, coffee or tea	7½-oz	BX	7350-00-725-6500
Cup, coffee mug	8-oz	BX	7350-00-732-9500
Dish, fruit	5⅛"	BX	7350-00-738-1000
Plate, dessert or salad	6⁷⁄₁₆"	BX	7350-00-735-6000
Plate, dinner (24 to box)	9"	BX	7350-00-735-9000
Saucer, cup	5¼"	BX	7350-00-737-9000

Gold and blue pattern

Trimmed with gold and blue lines and Navy seal. Mediumweight. For flag officers' mess.

Cup, coffee or tea	7½-oz	BX	7350-00-272-9359
Plate, bread and butter	6¼"	BX	7350-00-271-1701
Plate, dessert or salad	7⅛"	BX	7350-00-271-1703
Plate, dinner (24 to box)	10"	BX	7350-00-271-1704
Plate, soup or cereal	7"	BX	7350-00-271-1705
Saucer, cup	6"	BX	7350-00-272-9529

Dark blue pattern

Narrow blue band, line, and anchor. Hotel weight. For officers' mess.

Cup, coffee or tea	7½-oz	BX	7350-00-375-2477
Dish, fruit	5¼"	BX	7350-00-264-5398
Plate, bread and butter	6¼"	BX	7350-00-192-1932
Plate, dessert or salad	7⅛"	BX	7350-00-192-1938
Plate, dinner (24 to box)	10"	BX	7350-00-192-1933
Plate, soup or cereal	7"	BX	7350-00-222-3288
Saucer, cup	6"	BX	7350-00-253-0594

Dinnerware, Glass

White, opalescent. Nonporous, break-, chip-, and stain-resistant. Will not warp, crack, or craze. May be used for baking. Decorated with narrow blue band No. 15193. Height and dia. shown. DD-T-90.

Bowl	2⅛ x 5⅝"	DZ	7350-00-823-7393
Soup bowl	1⅝ x 9⅛"	DZ	7350-00-823-7562
Drinking cup	6½-oz	DZ	7350-00-823-7394
	10½-oz	DZ	7350-00-823-7563
Mug	6½-oz	DZ	7350-00-404-9782
Sauce dish	1½ x 5½"	DZ	7350-00-823-7398
Bread and butter plate	⅝ x 6¾"	DZ	7350-00-823-7397
3-compartment plate	6½ x 1½"	DZ	7350-00-402-9463
Dish, eating	4¾ x 1¼"	DZ	7350-00-177-4943
	5½ x ⅜"	DZ	7350-00-402-9464
Dinner plate	9"	DZ	7350-00-823-7396
Platter	12½"	DZ	7350-00-823-7560
Saucer	5⅞"	DZ	7350-00-823-7395

Dinnerware, Plastic

See also Cafeteria serving ware, Class 7350.

Tough, virtually unbreakable and chip-proof. Fade-proof pastel shade. Color permeates plastic throughout. May be sterilized at high temperatures or washed in machines without harm. Lightweight, easy to handle, stacks compactly. L-T-48.

(See Stain remover and chlorine base dishwashing compound.)

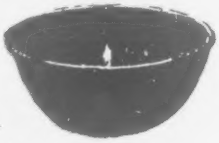
Cup, 1 handle	10-oz	DZ	7350-01-036-5424

Sahara Sand, Class 1

(176)

Bowl, general-purpose	16-oz	DZ	7350-00-205-3220

(176)



(177)

Bowl, serving, fruit	6½-oz	DZ	7350-00-205-3160

(177)

Cup and saucer

Cup	8-oz	DZ	7350-00-634-2864

(178)

Saucer, cup, matching		DZ	7350-00-205-3213

(178)

(179)

Dish, serving, vegetable	1-qt	EA	7350-00-205-3161

(182)

(179)

(180)

Plate, dinner	10"	DZ	7350-00-205-3219

8135-Industrial

Paper, Kraft, Freezer Wrap

Plastic-coated white UU-P-272.

20" x 1,000-ft.

RO 8135-00-584-2698

Paper, Meat Interleaving

Waxed double sheets with one punched hole. 5 3/16" square. Prevents shrinkage and loss of meat juices. 12,000 sheets to package. UU-P-1218

PG 8135-00-994-2976

Paper, Protective

Pressure-sensitive, adhesive-coated, synthetic latex impregnated. For protecting aluminum or other metal sheets from abrasion during metalworking operations.

36" x 60-yd

RO 8135-00-946-2090

Paper, Volatile Corrosion Inhibitor Treated

For general application. Medium duty. Kraft, creped or embossed. Roll form. 36" wide, 200 yds. long. Type I, class 2, style B, MIL-P-3420.

RO 8135-00-810-0481

Paper, Waxed

For interleaving sheets of postage stamps. 1,000 sheets to package.

8 9/16 x 10 3/16"

PG 8135-00-762-6221

Paper, Wrapping

Chemically neutral

Noncorrosive sulfate pulp. Use as dust protection. 36" wide, 600-ft roll. MIL-P-17667.

Flat paper, 30-lb

RO 8135-00-558-1242

Stretchable, creped in one direction, 35-lb.

RO 8135-00-558-1245

Dispensary

Bleached sulfate pulp. Sanitary for food, drugs, or other items.

40-lb. stock, 9" roll dia. 1,228-ft roll

24" wide RO 8135-00-291-0342

Vegetable parchment. For instruments and dressings before, during, and after sterilization. Treated with glycerine or other suitable nonvolatile humectant. 500 sheets to package. UU-P-1144

6 x 6" PG 8135-00-899-3390

Laminated and creped

Use over grades A and C greaseproof wrappers for added protection against mechanical damage, as a wrapper over items enclosed in water-vaporproof bags; as contact wrapper on nonprecision parts; and as protective band on radial type engine cylinders. Not a substitute for waterproof barrier material. MIL-P-130.

Heavy-duty

36" x 100-yd

RO 8135-00-664-0029

36" x 200-yd

RO 8135-00-702-3158

Medium-duty

36" x 200-yd

RO 8135-00-680-2777

Meat

Water-resistant kraft paper. For wrapping fresh meats for short periods of refrigerated storage. Length of roll shown. MIL-P-43112.

1,200 ft

18" wide RO 8135-00-579-9171

1,228 ft

24" wide RO 8135-00-292-9604

36" wide RO 8135-00-292-9605

Tissue

Bleached 100% chemical wood pulp. Use as an initial wrap to protect items from breaking, scratching, and dust during shipment or storage. 480 sheets to ream. UU-P-553.

Regular bleached

20 x 30" RM 8135-00-242-7303

Neutral (antitarnish) bleached

24 x 36" RM 8135-00-281-1435

Waxed

Wet-waxed. 24" wide roll, about 9½" dia. For general use in galleys, bakeries, commissaries, and for overwrapping wax-dipped packages. 3,000-ft. roll. UU-P-134.

RO 8135-00-264-3826

Self-sealing. Use for wrapping bread. Waxed both sides.

16" wide, 820-ft. roll

RO 8135-00-171-1543

18" wide, 1,228-ft. roll

RO 8135-00-281-9086

Dry-waxed. Chemical wood. UU-P-270.

White. Food wrapping.

12 x 18". 500 sheet ream.

RM 8135-00-290-3414

9-10" dia. roll

1,000-yd. roll

12" wide RO 8135-00-526-1902

18" wide RO 8135-00-171-1552

250-yd. roll

36" wide RO 8135-00-285-1161

Brown. General purpose.

9-10" dia. roll

1,000-yd. roll

24" wide RO 8135-00-663-9806

Paperboard, Wrapping Cushioning

Corrugated molded pulp, or nodule packing. Single-faced; use for inner packing and outer wrapping of parcel post shipments and packages. Protects against breakage, abrasion, tearing, dirt, dust, and foreign matter. Flexible inner cushion insures maximum resiliency and easy folding; strong outer kraft covering. Backing sheet required.

Heavy-duty. Commercial Item Description (CID) A-A-1797.

24" w., 250-ft

RO 8135-00-281-3920

36" w., 250-ft

RO 8135-00-242-5610

48" w., 250-ft

RO 8135-00-290-3400

Light-duty. Commercial Item Description (CID) A-A-1798

36" w., 250-ft

RO 8135-00-290-3402

Plastic Sheet

Plastic film wrap. Roll width and length shown. Commercial Item Description (CID) A-A-1742.

Household wrap. Soft self-clinging film for packaging food and other products.

11½" x 100-ft

RO 8135-00-043-5331

12" x 200-ft

RO 8135-00-984-1127

12" x 1,000-ft

RO 8135-00-754-2692

For covering food dishes, glasses, and for food packaging. Perforated rolls, 0.0005" thick. No. of sheets to roll in parentheses.

6 x 5" (3,000)

RO 8135-00-020-0213

24 x 28" (400)

RO 8135-00-021-5865

Soft stretch film. For hand wrapping of produce 0.0006" thick. Not perforated. Class VII, L-P-370.

12" x 5,000-ft

RO 8135-00-838-0121

15" x 5,000-ft

RO 8135-00-838-0122

Has max. bloom retention for hand wrapping fresh meats 0.0007" thick. Class V, L-P-370.

RO 8135-00-405-9292

Normal impact strength polyethylene plastic film. Low-slip. Protects from dust. Highly water-resistant; moderately vapor-resistant. Commercial Item Description (CID) A-A-1829.

Transparent

For use in contact with food. 100-ft roll 0.004" thick.

10-ft wide RO 8135-00-855-338

Not for use in contact with food

20 x 50", 0.002" thick

SH 8135-00-985-413

100-ft. roll, 0.004" thick

3-ft wide RO 8135-00-068-946

8-ft. wide RO 8135-00-584-061

100-ft. roll, 0.006" thick

12-ft. wide RO 8135-00-579-648

16-ft. wide RO 8135-00-618-178

200-ft. roll, 0.002" thick

8-ft. wide RO 8135-00-584-061

Black

100-ft. roll, 0.006" thick

10-ft. wide RO 8135-00-579-64

20-ft. wide RO 8135-00-579-64

ormal impact strength polyethylene sheet. ow-slip, untreated. Not for use with food. 00" long, 86" wide, 0.002" thick. Type I, ass 1, grade A, finish 1, Commercial Item escription (CID) A-A-1829.
......SH...... 8135-01-019-9476

lexible vinyl plastic film. For use in temperaures 0-130° F. Waterproof. For packaging. lear, colorless. Heat-sealable. Commercial tem Description (CID) A-A-1829.

36" sq. 0.020" thick. Flat cut.
......SH...... 8135-00-585-8756

48" **wide.** 0.004" thick.
50-yd......RO...... 8135-00-282-5635

54" **wide.** 0.020" thick.
50-yd......RO...... 8135-00-050-7698

Soft shrink film for hand or automatic wrapping of fresh meats. 0.0005" thick. 6,800-ft. ong. L-P-370.
15" wide......RO...... 8135-00-476-5266
18" wide......RO...... 8135-00-476-5268

Plastic Strip

Clear, flexible vinyl flat cuts. Use in temperatures from −40 to 130° F. For packaging or for a waterproof cover. Heat-sealable. 0.012" thick. Commercial Item Description (CID) A-A-1768.
6 x 5"......EA...... 8135-00-542-5761

Polyurethane, Foam Chemical

Semirigid for packaging. Component A, MIL-P-26514.
50-lb......DR...... 8135-00-130-9754

Liquid. Semirigid for packing. 50-lb. drum. Component B, MIL-P-26514.
5-gal......DR...... 8135-00-130-9753

Protector, Steel Strapping

For use on stake products of flat and gondola cars. For heavy-duty steel strapping. 1¼-2" wide, 7" long, 0.42" thick. Interlake Steel 116.
......EA...... 8135-00-423-6735

Tag, Shipping

Reinforced eyelet. UU-T-81.

Rectangular cloth tags. Commercial Item Description (CID) A-A-1266.

Wire tie. Metal eyelet.

3¾ x 1⅞" Wht
......MX...... 8135-00-292-2347

6¼ x 3⅛" Yllw
......MX...... 8135-00-178-9192

6¼ x 3⅛" Red
......MX...... 8135-00-178-9191

6¼ x 3⅛" Wht
......HD...... 8135-00-178-9193

Cotton string. White. Metal eyelet. Grade 3.
1⅜ x 2¾"......MX...... 8135-00-292-2342
1⅞ x 3¾"......MX...... 8135-00-292-2343
2⅝" x 5¼"......MX...... 8135-00-292-2345
2⅞ x 5¾"......MX...... 8135-00-292-2346

Cotton string. White. Metal eyelet. Grade 2.
2⅞ x 5¾"......HD...... 8135-00-290-5510

Rectangular paper tags. Commercial Item Description (CID) A-A-900.

For domestic use. Metal bound.

Wire tie. Manila.
1⅝ x 3¼"......MX...... 8135-00-271-1746

Cotton string

2⅜ x 4¾"
Wht......HD...... 8135-00-178-9146

2⅝ x 5¼". 100 to package.
Wht......PG...... 8135-00-290-5506

3⅛ x 6¼"
Blue......HD...... 8135-00-178-9147
Grn......HD...... 8135-00-178-9148
Wht......HD...... 8135-00-178-9151

Cotton string. Yellow coated chemical wood stock.
3⅛ x 6¼"......HD...... 8135-00-178-9152

No string or tie

2⅜ x 4¾"
Manila......MX...... 8135-00-178-9194

3⅛ x 6¼"
Red......MX...... 8135-00-178-9164

Wire tie

Manila

1⅞ x 3¾"
......MX...... 8135-00-292-2357

2⅝ x 5¼"
......HD...... 8135-00-926-5252

Red. 2⅜ x 4¾".
......HD...... 8135-00-952-0672

Cotton string. Manila.
1⅜ x 2¾"......MX...... 8135-00-292-2350
1⅝ x 3¼"......MX...... 8135-00-240-1388
1⅞ x 3¾"......MX...... 8135-00-292-2351
2⅛ x 4¼"......MX...... 8135-00-292-2353
2⅜ x 4¾"......MX...... 8135-00-292-2354

500 to box.
2⅝ x 5¼"......BX...... 8135-00-292-2355
2⅞ x 5¾"......MX...... 8135-00-292-2356
3⅛ x 6¼"......MX...... 8135-00-238-6917

White paper with green border. Legend: "Return Address." 12" cotton string. UU-T-81.

3⅛ x 6¼"
......MX...... 8135-00-240-1394

Shipping tag for marking hazardous materials. For use in very humid areas. Wire tie. Preprinted on both sides. Hazardous material data on one side and DOT data on other. 500 to box. Type B, class 2, size 8, UU-T-81.
......BX...... 8135-00-454-9347

Tag, Stock Marking

Round paper tags

Heavy-duty with metal rims. Circular. Chemical wood stock. Smooth surface. Dia. shown. 9" cotton string. Commercial Item Description (CID) A-A-1916.
¹⁵⁄₁₆" Wht......MX...... 8135-00-985-5751
1⁹⁄₁₆" Wht......MX...... 8135-00-239-1548
2¼" Wht......MX...... 8135-00-178-9200

Tape, Gummed

For sealing and banding paper and paper products. One side coated with water-activated adhesive. Commercial Item Descriptions shown.

Two-ply reinforced asphalt-laminated. 30-lb. Not for use with food products. CID A-A-1671.

450-ft.
1½" w......RO...... 8135-00-926-4858
3" w......RO...... 8135-00-598-6097

Two-ply reinforced, nonasphalt-laminated. 30-lb. Water-resistant, flexible, nonstaining. Use for food packaging. CID A-A-1672.

Easily stripped from container for reuse. 375-ft. roll, ½" core dia.
2" w......DZ...... 8135-00-926-8989

8 rolls to box.
3" w......BX...... 8135-00-155-5473

Not reusable—adheres strongly to container. 450-ft. roll.
2" w......RO...... 8135-00-854-4052

One-ply nonreinforced

Light-duty, 35-lb. CID A-A-1492.

800-ft. roll
1½" w......RO...... 8135-00-270-8726
2" w......RO...... 8135-00-271-1445

Medium-duty, 60-lb. 600-ft. roll
2" w......RO...... 8135-00-272-9346
2½" w......RO...... 8135-00-271-1446
3" w......RO...... 8135-00-270-8717

Heavy-duty, 90-lb. 375-ft. roll
3" w......RO...... 8135-00-272-9347

Brown kraft. Water-activating adhesive. For taping closures of fiberboard boxes. Commercial Item Description (CID) A-A-1492.

1" x 6,000-ft. ½" inside core.
......SL...... 8135-00-272-2503

2" x 1,000-ft. 1¾" inside core.
......RO...... 8135-00-985-7032

Tie, Metal Strip, Bag

Paper-covered wire strips. Twist-seal plastic bags, garbage can liners. 250 to bundle. Insta-Tie.
6 x ¼"......BD...... 8135-00-846-8409

Tie, Strip, Bag

Single-loop bale tie wire No. 15. 250 lengths (10-ft.) to bundle.
......BD...... 8135-00-782-6223

7½" long tie wire. 0.072" thick, 5,000 to bundle.
......BD...... 8135-00-263-9317

Wire ties with protective finish, 2,500-ft. long. 0.007" wire size. Commercial Item Description (CID) A-A-1734.
Blk......SL...... 8135-00-481-9285

8105-Industrial

6¼ x 14¼ x 5"

1-gal	BD	**8105-00-702-6858**

Millinery

Striped brown. Flat style, unbleached kraft, machine-finished. 40-50 lbs. Commercial Item Description (CID) A-A-309.

10 x 13". 2,000 to bale.

Size 10	BE	**8105-00-682-6663**

12 x 15". 2,000 to bale.

Size 12	BE	**8105-00-682-6664**

15 x 18". 1,000 to bale. Type 1

Size 15	BE	**8105-00-682-6665**

17 x 21". 1,000 to bale. Type 1

Size 17	BE	**8105-00-682-6666**

21 x 24". 1,000 to bale. Type 1

Size 21	BE	**8105-00-682-6667**

Notion

Striped brown. Flat style, unbleached 30-lb kraft. About ½" lip. Commercial Item Description (CID) A-A-309

5 x 7½". 6,000 to bale

Size 5	BE	**8105-00-682-6659**

6¼ x 9¼". 6,000 to bale

Size 6	BE	**8105-00-682-6660**

7½ x 10½". 4,000 to bale.

Size 7	BE	**8105-00-682-6661**

8½ x 11". 4,000 to bale.

Size 8	BE	**8105-00-682-6662**

Shopping

Self-opening (automatic), with handles. 65-lb. 250 to bundle. Commercial Item Description (CID) A-A-302

17¾ x 13 x 6"

	BD	**8105-00-857-2250**

Waste receptacle

Square, waxed. 8 x 17⅛ x 7¾". For insertion in sanitary waste receptacles, for the disposal of garbage, refuse, and infectious waste. 600 to box. Commercial Item Description (CID) A-A-310

	BX	**8105-00-050-7266**

Bag, Pilot Relief

Disposable. Flask shape. 500cc. capacity. Steel or vinyl closure. MIL-B-83665

7 x 12"	EA	**8105-00-922-9469**

Bag, Plastic

Delicate instruments and electronic components

Transparent. Printed "Reusable—Do Not Discard." Three-ply fabrication of 0.004" thick polyethylene and 0.187" thick cellular cushioning material. 50 to box. Commercial Item Description (CID) A-A-1668

4 x 6"	EA	8105-00-137-9132
6 x 8"	EA	8105-00-137-9133
8 x 10"	BX	8105-00-137-9134
8 x 12"	EA	8105-00-137-9135
10 x 12"	EA	8105-00-137-9136
12 x 12"	EA	8105-00-137-9131

Entomological specimens

Clear. 0.002" thick. Made from one sheet of plastic. One end heat-sealed. Leakproof. Use as a container for rodents, rodent parasites and other entomological specimens in field-preventive medicine procedures. MIL-B-43255

6 x 12"	HD	**8105-00-401-2000**
12 x 16"	HD	**8105-00-401-2010**

Food packaging

Polyethylene. For packaging produce and poultry. Commercial Item Description (CID) A-A-1246

Perforated

For fresh fruits and vegetables. With wire ties. 0.0013" thick.

Plain, unprinted

5 x 13 x 3½"

	MX	**8105-00-579-9165**
6 x 15 x 3"s	MX	**8105-00-579-9163**
8 x 20 x 3"	MX	**8105-00-579-9162**

Printed—"Fresh" with price and weight shield.

6½ x 10 x 4½"

	MX	**8105-00-684-8980**

For produce. With wire ties. 0.0015" thick.

6 x 9 x 4"	MX	**8105-00-721-9910**
6 x 17 x 4"	MX	**8105-00-721-9907**
8 x 18 x 4"	MX	**8105-00-721-9906**

For potatoes. With wire ties. 0.003" thick. 400 to box.

15 x 29½"	BX	**8105-00-579-9167**

Nonperforated

For produce. Square bottom. 0.0015" thick.

5 x 13 x 3½"

	MX	**8105-00-680-0852**

5 x 16 x 3½"

	MX	**8105-00-680-0853**

For poultry. Round bottom. With wire ties. 0.0015" thick.

8 x 15"	MX	**8105-00-721-9912**
12 x 18"	MX	**8105-00-721-9913**

Polyethylene bread bag. 0.001" thick. Wide bottom. 3,000 bags to box. MIL-B-43706

8¼ x 15⅝ x 4⅛"

	BX	8105-00-180-6041

Garments

Clear. 0.004" thick. 500 to dispenser box. L-P-378

36 x 21 x 4" deep. Colorless.

	BX	8105-00-116-2922

54 x 21 x 4" deep. Blue

	BX	8105-00-116-2921

Perforated, preformed for suits. 0.0004" thick. 1,000 bags per roll. MIL-B-43716

24 x 36"	RO	8105-00-656-0932

General packaging

Clear, heat-sealable. 0.006" thick. Heavy-duty. MIL-B-117

Waterproof, greaseproof, and vaporproof

Transparent

20 x 25"	EA	8105-00-269-4662

Opaque. Box of 50

11 x 16"	BX	8105-01-011-2563
13 x 18"	BX	8105-01-011-2564
17 x 21"	BX	8105-01-011-2565
18 x 18"	BX	8105-01-011-2566

Waterproof and greaseproof. Transpare 50 to package.

18 x 12"	PG	**8105-00-902-65**

Waterproof. Transparent.

4 x 8"	EA	**8105-00-050-66**

Medical materials

Button and string or snap type closure. Use hold small items of medical material in fi kits and assemblies. 0.006" thick.

5½ x 11½"	HD	8105-00-299-85

Protective cushioning

Heat-sealable, cellular, clear. Flat botto ³⁄₁₆" thick. 50 bags to bundle.

5 x 4"	BD	8105-00-116-36
6 x 5"	BD	8105-00-116-36
8 x 7½"	BD	8105-00-116-36
13 x 10½"	BD	8105-00-116-36

Rucksack liner

Transparent polyethylene bag. For use in si pockets of rucksack to protect items fro moisture. 0.004" thick. Colorless. Flat botto MIL-R-43574.

15 x 9"	HD	8105-00-935-71
25 x 18½"	HD	8105-00-935-71

Sandwich

Polyethylene, flat. 0.008" thick. 6¼" wi 5⅛" high. Fold-lock type for easy seal bags to dispensing box. Commercial Item D scription (CID) A-A-148.

	BX	8105-00-773-75

Shrink tunnel

Polyethylene single-wall, heat-shrinkable fil Preformed gusset bag. 50" face width, 4 gusset width. 120-lb. roll. For use in shri tunnel. Bags per roll in parentheses. Thic ness shown. Commercial Item Descripti (CID) A-A-1829.

65" long. For 40 x 48 x 43" pallet load.

(32) 0.008"	RO	8105-00-191-39
(42) 0.006"	RO	8105-00-191-37

76" long. For 40 x 48 x 54" pallet load.

(32) 0.008"	RO	8105-00-025-126
(42) 0.006"	RO	8105-00-191-370

Waste receptacle

Polyethylene bags for packaging and disposa of garbage, refuse, or contaminated waste. Di mensions are width, gusset, length (squar bags), and width, length (flat bags). Comm cial Item Description (CID) A-A-1668.

Square. Wire tie closure. Thickness shown.

12 x 8 x 22"

0.002"	MX	8105-00-726-55

13 x 12 x 24". Fits square and round offi trash cans. 250 to box.

0.002"	BX	8105-00-655-82

13 x 12 x 24". 250 to box.

0.003"	BX	8105-01-033-14

16 x 14 x 37". 250 to box.

0.002"	BX	8105-00-726-56

19½ x 14½ x 38½". 125 to box.

0.0025"	BX	8105-00-655-82

19½ x 14½ x 38½". 125 to box.

0.004"	BX	8105-01-033-14

23 x 17 x 48". 250 to box.

0.002"	BX	8105-00-726-56

NSN/ITEM LISTING

NSN	Item Name	AAC	Selling Price	Annual Dollar Volume
8105000251263	BAG,PLASTIC	G	64.31	74406.66
8105000506655	BAG,PLASTIC	G	2.52	18164.16
8105000608961	BAG,PLASTIC	G	15.99	138777.20
8105000709496	BAG,PLASTIC	G	11.17	19033.68
8105001162921	BAG,PLASTIC	J	27.25	4360.00
8105001162922	BAG,PLASTIC	J	25.48	2548.00
8105001163641	BAG,PLASTIC	J	13.45	1667.80
8105001163642	BAG,PLASTIC	J	10.03	461.38
8105001163643	BAG,PLASTIC	J	7.79	171.38
8105001163645	BAG,PLASTIC	G	12.20	11114.20
8105001379131	BAG,PLASTIC	G	32.17	258518.11
8105001379132	BAG,PLASTIC	G	13.93	54368.79
8105001379133	BAG,PLASTIC	G	17.14	78415.50
8105001379134	BAG,PLASTIC	G	22.08	62883.84
8105001379135	BAG,PLASTIC	G	25.67	82554.72
8105001379136	BAG,PLASTIC	G	27.65	145300.75
8105001450163	BAG,PLASTIC	G	39.55	203049.70
8105001490309	BAG,PLASTIC	J	1.38	1033.62
8105001594998	BAG,PLASTIC	G	4.33	5468.79
8105001806041	BAG,PLASTIC	G	37.39	6057.18
8105001913701	BAG,PLASTIC	G	62.65	522250.41
8105001913776	BAG,PLASTIC	G	52.80	55651.20
8105001913902	BAG,PLASTIC	G	51.90	176511.91
8105002000195	BAG,PLASTIC	G	12.59	294077.22
8105002694662	BAG,PLASTIC	G	5.04	12448.80
8105002998532	BAG,PLASTIC	G	20.14	277368.06
8105002998591	BAG,PLASTIC	G	17.79	4500.87
8105003307264	BAG,PLASTIC	G	18.89	28863.92
8105004012000	BAG,PLASTIC	G	0.91	52357.76
8105004012010	BAG,PLASTIC	G	1.99	14783.71
8105005798451	BAG,PLASTIC	G	13.85	464764.47
8105005799162	BAG,PLASTIC	G	15.11	40993.43
8105005799163	BAG,PLASTIC	G	9.66	21802.62
8105005799165	BAG,PLASTIC	G	8.02	5020.52
8105005799167	BAG,PLASTIC	G	28.83	6025.47
8105005799285	BAG,PLASTIC	G	1.27	8261.35
8105005799286	BAG,PLASTIC	G	0.96	8066.88
8105006558285	BAG,PLASTIC	Y	6.95	2071.10
8105006558286	BAG,PLASTIC	Y	12.60	39186.00
8105006560932	BAG,PLASTIC	G	30.10	35096.60
8105006600603	BAG,PLASTIC	J	2.31	709.17
8105006800503	BAG,PLASTIC	G	1.10	2489.30
8105006800852	BAG,PLASTIC	G	9.38	22043.00
8105006800853	BAG,PLASTIC	G	11.09	9115.98
8105006848980	BAG,PLASTIC	J	30.80	1293.60
8105007027175	BAG,PLASTIC	G	5.60	24074.40
8105007027177	BAG,PLASTIC	G	0.84	400.68
8105007027178	BAG,PLASTIC	G	7.53	3802.65
8105007219906	BAG,PLASTIC	G	15.66	15440.76
8105007219907	BAG,PLASTIC	G	11.91	9087.33
8105007219910	BAG,PLASTIC	J	23.10	1201.20

NSN	Item Name	AAC	Selling Price	Annual Dollar Volume
8105007219912	BAG, PLASTIC	G	11.50	10890.50
8105007219913	BAG, PLASTIC	G	16.98	19238.34
8105007265607	BAG, PLASTIC	G	49.48	1533682.13
8105007590794	BAG, PLASTIC	G	15.16	300440.88
8105007737581	BAG, PLASTIC	G	0.44	125071.32
8105008357212	BAG, PLASTIC	G	77.29	244081.83
8105008377753	BAG, PLASTIC	G	11.24	304559.03
8105008377754	BAG, PLASTIC	G	15.34	463129.94
8105008377755	BAG, PLASTIC	G	23.04	636710.44
8105008377756	BAG, PLASTIC	G	17.12	346525.94
8105008377757	BAG, PLASTIC	G	21.73	764026.81
8105009026508	BAG, PLASTIC	G	10.68	28355.40
8105009357146	BAG, PLASTIC	G	3.68	5689.28
8105009357147	BAG, PLASTIC	G	3.09	3287.76
8105009479856	BAG, PLASTIC	G	1.51	5371.07
8105010969527	BAG, PLASTIC	H	5.62	12234.74
8105010969528	BAG, PLASTIC	H	22.56	26733.60
8105010974507	BAG, PLASTIC	H	10.30	19662.70
8105011198109	BAG, PLASTIC	H	37.14	11921.94
8105011198110	BAG, PLASTIC	H	27.16	3204.88
8105011198111	BAG, PLASTIC	H	12.83	346.41
8105011203370	BAG, PLASTIC	H	32.01	16357.11
8105011203371	BAG, PLASTIC	H	28.31	4161.57
8105011203372	BAG, PLASTIC	H	22.03	10398.16
8105011203373	BAG, PLASTIC	H	19.68	8304.96
8105011203374	BAG, PLASTIC	H	26.11	3028.76
8105011203375	BAG, PLASTIC	H	13.76	16319.36
8105011203376	BAG, PLASTIC	H	10.19	16874.64
8105011203377	BAG, PLASTIC	H	8.79	14046.42
8105011203378	BAG, PLASTIC	H	7.54	10880.22
8105011203379	BAG, PLASTIC	H	6.73	1420.03
8105011203380	BAG, PLASTIC	H	4.33	1697.36
8105011203381	BAG, PLASTIC	H	3.49	2125.41
8105011203382	BAG, PLASTIC	H	3.48	1722.60
8105011480280	BAG, PLASTIC	G	24.73	19363.59
8105011506256	BAG, PLASTIC	G	14.16	82326.24
8105011511097	BAG, PLASTIC	G	12.36	13447.68
8105011740941	BAG, PLASTIC	G	47.39	413051.25
8105011740942	BAG, PLASTIC	G	81.84	111629.76
8105011740943	BAG, PLASTIC	G	45.22	54444.88
8105011740944	BAG, PLASTIC	G	33.39	24307.92
8105011740945	BAG, PLASTIC	G	44.07	161913.17
8105011755532	BAG, PLASTIC	G	47.39	143591.70
8105011755533	BAG, PLASTIC	G	33.39	42705.81
8105011839762	BAG, PLASTIC	Y	4.55	445.90
8105011839764	BAG, PLASTIC	G	28.89	3595244.75
8105011839765	BAG, PLASTIC	Y	15.90	11034.60
8105011839767	BAG, PLASTIC	G	36.30	1479660.63
8105011839768	BAG, PLASTIC	G	22.61	18372096.00
8105011839769	BAG, PLASTIC	G	23.69	4733594.00
8105011847159	BAG, PLASTIC	G	37.77	1233643.75

NSN	Item Name	AAC	Selling Price	Annual Dollar Volume
8105011958730	BAG, PLASTIC	G	16.69	9904247.00
8105012174311	BAG, PLASTIC	J	235.55	1884.40
8105012174312	BAG, PLASTIC	J	161.00	5957.00
8105012177252	BAG, PLASTIC	J	218.47	873.88
8105012177587	BAG, PLASTIC	J	70.00	2030.00
8105012177588	BAG, PLASTIC	J	70.00	1610.00
8105012177589	BAG, PLASTIC	J	105.00	3570.00
8105012177590	BAG, PLASTIC	J	77.00	3080.00
8105012177591	BAG, PLASTIC	J	140.00	3360.00
8105012177592	BAG, PLASTIC	J	140.00	4340.00
8105012177593	BAG, PLASTIC	J	133.00	532.00
8105012177594	BAG, PLASTIC	J	161.00	3542.00
8105012177595	BAG, PLASTIC	J	42.00	5208.00
8105012182051	BAG, PLASTIC	H	45.83	549.96
8105012185320	BAG, PLASTIC	J	203.00	1015.00
8105012185321	BAG, PLASTIC	J	139.90	3637.40
8105012185322	BAG, PLASTIC	J	216.03	1296.18
8105012185323	BAG, PLASTIC	J	252.99	9107.64
8105012185324	BAG, PLASTIC	J	111.03	444.12
8105012185325	BAG, PLASTIC	J	101.60	304.80
8105012185326	BAG, PLASTIC	J	182.00	910.00
8105012213233	BAG, PLASTIC	G	66.78	13957.02
8105012213234	BAG, PLASTIC	G	50.36	4985.64
8105012213235	BAG, PLASTIC	G	69.25	4224.25
8105012213236	BAG, PLASTIC	G	47.39	28054.88
8105012213237	BAG, PLASTIC	G	53.51	52332.78
8105012213238	BAG, PLASTIC	G	42.81	19435.74
8105012213239	BAG, PLASTIC	G	55.40	60773.80
8125004887952	BOTTLE, APPLICATOR	G	0.62	333880.53
8125007824000	BOTTLE, APPLICATOR	G	0.45	8115.75
6640006561620	BOTTLE, ASPIRATOR	H	46.52	7489.72
8125008249058	BOTTLE, SCREW CAP	G	0.32	3067.20
7350000825741	CUP, PLASTIC	G	9.90	2626004.50
7350001456126	CUP, PLASTIC	G	12.30	113233.80
7350007219003	CUP, PLASTIC	G	8.80	452126.41
7350007617467	CUP, PLASTIC	G	16.59	43051.05
7350009145088	CUP, PLASTIC	G	21.40	94887.60
7350009145089	CUP, PLASTIC	G	18.20	175320.61
7350009261661	CUP, PLASTIC	G	13.10	506026.81
8135000529070	CUSHIONING MATERIAL	I	12.12	14762.16
8135000529077	CUSHIONING MATERIAL	I	9.41	22631.05
8135001161443	CUSHIONING MATERIAL	I	26.08	6885.12
8135001161447	CUSHIONING MATERIAL	I	54.23	27603.07
8135001299523	CUSHIONING MATERIAL	I	115.20	230.40
8135001329568	CUSHIONING MATERIAL	I	3.56	601.64
8135001429004	CUSHIONING MATERIAL	I	34.00	43384.00
8135001429005	CUSHIONING MATERIAL	I	12.10	3025.00
8135001429008	CUSHIONING MATERIAL	I	15.90	1844.40
8135001429016	CUSHIONING MATERIAL	I	24.50	20604.50
8135001429021	CUSHIONING MATERIAL	I	42.18	8562.54
8135001429746	CUSHIONING MATERIAL	I	48.00	6000.00

NSN	Item Name	AAC	Selling Price	Annual Dollar Volume
8135001450137	CUSHIONING MATERIAL	I	10.00	1260.00
8135001805922	CUSHIONING MATERIAL	I	56.11	19694.61
8135001806395	CUSHIONING MATERIAL	I	25.16	4025.60
8135001817456	CUSHIONING MATERIAL	I	13.60	5984.00
8135001817670	CUSHIONING MATERIAL	I	37.21	855.83
8135001838814	CUSHIONING MATERIAL	I	37.95	3984.75
8135001838823	CUSHIONING MATERIAL	I	28.73	10745.02
8135002929789	CUSHIONING MATERIAL	I	3.32	2101.56
8135002929800	CUSHIONING MATERIAL	I	79.25	3328.50
8135003004904	CUSHIONING MATERIAL	I	60.16	1564.16
8135003004905	CUSHIONING MATERIAL	I	97.21	4568.87
8135003972583	CUSHIONING MATERIAL	H	10.08	19897.92
8135005436843	CUSHIONING MATERIAL	I	48.00	192.00
8135005436844	CUSHIONING MATERIAL	I	3.69	5926.14
8135006019221	CUSHIONING MATERIAL	I	78.50	392.50
8135006561044	CUSHIONING MATERIAL	I	38.93	3347.98
8135006640057	CUSHIONING MATERIAL	I	47.37	34011.66
8135006646948	CUSHIONING MATERIAL	I	13.89	2389.08
8135006646958	CUSHIONING MATERIAL	I	22.66	5415.74
8135006848982	CUSHIONING MATERIAL	I	34.85	871.25
8135008086446	CUSHIONING MATERIAL	I	35.84	37918.72
8135008497847	CUSHIONING MATERIAL	H	61.16	611.60
8135008556968	CUSHIONING MATERIAL	I	34.57	10198.15
8135008556969	CUSHIONING MATERIAL	I	33.76	51956.64
8135008841201	CUSHIONING MATERIAL	H	19.16	8257.96
8135008923917	CUSHIONING MATERIAL	I	28.00	476.00
8135009262026	CUSHIONING MATERIAL	I	4.29	308.88
8135009262027	CUSHIONING MATERIAL	I	9.10	6106.10
8135009262028	CUSHIONING MATERIAL	H	11.97	2142.63
8135009262169	CUSHIONING MATERIAL	I	61.20	612.00
8135009268990	CUSHIONING MATERIAL	I	11.10	66.60
8135009268991	CUSHIONING MATERIAL	I	24.80	30082.40
8135009350983	CUSHIONING MATERIAL	I	14.60	18074.80
8135009356596	CUSHIONING MATERIAL	I	11.56	25062.08
8135009857313	CUSHIONING MATERIAL	I	11.48	172.20
8135009899888	CUSHIONING MATERIAL	I	44.45	4978.40
8135009899889	CUSHIONING MATERIAL	H	14.30	5720.00
8135010039304	CUSHIONING MATERIAL	I	19.25	192.50
8135010058974	CUSHIONING MATERIAL	I	14.75	15989.00
8135010131824	CUSHIONING MATERIAL	I	70.85	425.10
8135010507970	CUSHIONING MATERIAL	I	69.39	1457.19
8135010573605	CUSHIONING MATERIAL	I	171.20	1883.20
8135010873603	CUSHIONING MATERIAL	H	27.50	6820.00
8135011175388	CUSHIONING MATERIAL	H	14.43	12279.93
7350004569746	LID,PLASTIC,DISPOSA	G	14.60	1284.80
7350010287101	LID,PLASTIC,DISPOSA	H	18.83	131.81
8135000215865	PLASTIC SHEET	G	8.21	40820.12
8135000435331	PLASTIC SHEET	G	0.78	16575.00
8135000507698	PLASTIC SHEET	G	148.77	45374.85
8135000586196	PLASTIC SHEET	H	71.44	20288.96
8135000689466	PLASTIC SHEET	G	5.05	11276.65

NSN	Item Name	AAC	Selling Price	Annual Dollar Volume
8135002825635	PLASTIC SHEET	G	25.77	32882.52
8135004059292	PLASTIC SHEET	G	23.53	51271.87
8135004765266	PLASTIC SHEET	G	31.28	14826.72
8135004765268	PLASTIC SHEET	G	37.23	56477.91
8135005796487	PLASTIC SHEET	G	30.34	606830.31
8135005796489	PLASTIC SHEET	G	18.74	633355.75
8135005796491	PLASTIC SHEET	G	16.86	173236.50
8135005840610	PLASTIC SHEET	G	10.24	82728.96
8135005840619	PLASTIC SHEET	G	12.53	14259.14
8135005858756	PLASTIC SHEET	J	3.44	502.24
8135006181783	PLASTIC SHEET	G	25.42	462033.91
8135007542692	PLASTIC SHEET	G	3.89	649198.25
8135008380121	PLASTIC SHEET	G	21.05	16608.45
8135008380122	PLASTIC SHEET	G	26.32	51560.88
8135008553387	PLASTIC SHEET	G	11.04	18878.40
8135009841127	PLASTIC SHEET	G	1.34	11111.28
8135010154139	PLASTIC SHEET	G	34.91	8797.32
8135010199476	PLASTIC SHEET	J	0.39	109.20
9330002021896	PLASTIC SHEET	G	4.03	18928.91
9330002021906	PLASTIC SHEET	G	105.89	14612.82
9330002021909	PLASTIC SHEET	G	209.63	8594.83
9330002021949	PLASTIC SHEET	G	42.83	5782.05
9330002861231	PLASTIC SHEET	G	15.12	715977.38
9330005840533	PLASTIC SHEET	G	4.00	10756.00
9330005856486	PLASTIC SHEET	G	121.74	47965.56
9330006843028	PLASTIC SHEET	G	19.42	66960.16
9330008198498	PLASTIC SHEET	G	18.59	10020.01
9330008198499	PLASTIC SHEET	G	24.83	21502.78
9330005806718	PLASTIC SHEET,PRESS	G	0.13	134008.03
9330006187214	PLASTIC SHEET,PRESS	G	11.80	464884.59
9330006187215	PLASTIC SHEET,PRESS	G	4.85	202346.84
9330006187216	PLASTIC SHEET,PRESS	G	13.59	570372.31
9330007529091	PLASTIC SHEET,PRESS	G	9.54	392408.81
8135000200213	PLASTIC STRIP	G	2.69	2447.90
9330005511424	PLASTIC STRIP	G	13.80	1090.20
9330006187217	PLASTIC STRIP,PRESS	G	4.05	39479.40
9330006187218	PLASTIC STRIP,PRESS	G	2.25	125561.25
9330007825575	PLASTIC STRIP,PRESS	G	11.88	39833.64

ACQUISITION ADVICE CODES

TABLE 2

Definition. A code indicating how (as distinguished from where) and under what restrictions an item will be acquired. The AAC is used in conjunction with the Source of Supply Modifiers. "Agency" refers to civil agencies with the exclusion of GSA and NSA.

CODE	EXPLANATION
A	Service/Agency Regulated
B	Inventory Control Point Regulated
C	Service/Agency Managed
D	DOD Integrated Managed-Stocked and Issued
E	Other Service Managed-Stocked and Issued
F	Fabricate or Assembly
G	GSA Managed, Stocked and Issued
H	Direct Delivery under a Central Contract
I	Direct Ordering from a Central Contract/Schedule
J	Not Stocked-Centrally Procured
K	Centrally Stocked for Overseas only
L	Local Purchase
M	Restricted Requisitions-Major Overhaul
N	Restricted Requisitioning-Disposal
O	Package Fuels
P	Restricted Requisition-Security Assistance Program (SAP)
Q	Bulk Petroleun Products

ACQUISITION ADVICE CODES

CODE	EXPLANATION
R	Restricted Requisition-Government Furnished Material (GFM)
S	Restricted Requisitioning-Other Service Funded
T	Condemned Item
U	Lead Service Managed
V	Terminal Item
W	Restricted Requisitioning-Special Instructions Apply
X	Semiactive Item-No Replacement
Y	Terminal Item (further identifier code "V" above on which wholesale stock has been exhausted)
Z	Insurance/Numeric Stockage Objective Item

Table 2. ACQUISITION ADVICE CODES

Appendix A

TESTIMONY OF
J. WINSTON PORTER
ASSISTANT ADMINISTRATOR FOR
SOLID WASTE AND EMERGENCY RESPONSE
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
COMMITTEE ON GOVERNMENT AFFAIRS
U.S. SENATE

September 20, 1988

Good afternoon, Mr. Chairman and members of the Committee. With me today is Sylvia Lowrance, Director of the Office of Solid Waste. I am pleased to have the opportunity to provide information on the increasing problems faced by States and localities with regard to solid waste, to update you on our activities in this area, and to discuss the views of the Environmental Protection Agency on S. 2298, the "Agricultural Commodity-Based Plastics Development Act of 1988."

I would like to begin by placing plastic wastes in the context of the overall solid waste picture. Then I will discuss our current activities which are related to this part of the solid waste stream. Following that discussion, I will address EPA's views on S. 2298.

I INTRODUCTION

Issues relating to plastic wastes are one part of a larger solid waste problem in the United States. Disposal capacity for all solid wastes is a serious concern. In addition, the events of the summer which have focused attention on environmental concerns of our coastline also raise specific concerns about plastics. Much of the plastic debris which finds its way to our beaches and oceans via recreational boats and from other sources is actually a part of the nation's municipal solid waste stream which has been improperly disposed. Therefore, I would like to put plastics in the context of the total municipal solid waste stream.

In 1986, the United States produced approximately 158 million tons of municipal waste. Plastics composed 7 percent, or 10 million tons, of that total. Plastic packaging alone accounted for approximately 6 million tons, or 4 percent of the total. By the year 2000, total plastics are expected to rise to 9 percent (16 million tons) with plastic packaging waste comprising a subtotal of 5 percent (8 million tons). This represents a 60 percent increase in plastic waste in the next 14 years. The total volume of municipal solid waste is expected to increase 22 percent and reach 193 million tons per year by that time.

Current solid waste management practices result in landfilling approximately 80% of municipal wastes, recycling 10%, and incinerating the remaining 10% (either with or without energy recovery). The increasing volume of waste, coupled with resistance to the siting of new landfills and the reduced capacity in existing landfills has led some parts of the nation to a near crisis situation. One-third of the nation's landfills will reach capacity by 1992. As a nation we are being forced to action--forced to begin to accept our individual and collective responsibility for waste generation and management and to address the solid waste problem.

II MUNICIPAL SOLID WASTE STRATEGY

Later this month EPA will publish a draft of a proposed agenda for action on municipal solid waste management. The proposed agenda will stress the need for integrated waste management, and will encourage the adoption of a holistic solid waste management plan. This will be a combination of management elements, including source reduction, recycling, and reuse, tailored to the needs of the community, which will reduce reliance on disposal options such as landfilling or incineration. This draft strategy reflects the Agency's judgement that it is preferable, whenever possible, to choose holistic approaches to problem solving. Plastic wastes are one important consideration in the development and implementation of a community's solid waste management strategy. Our preference for holistic approaches extends to the plastics waste problem as well as the development of any management effort.

III SOLID WASTE LANDFILL CRITERIA

On August 30 of this year EPA published proposed revisions to the criteria established for municipal solid waste landfills pursuant to the 1984 Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act. These criteria will establish a set of national minimum standards which State programs must meet. Once these criteria are issued in final form, should the State's regulatory program not be revised in a satisfactory fashion and in a timely manner, federal enforcement is authorized by the statute. While State regulatory requirements must be at least as stringent as those we will promulgate in the coming year, they may impose more stringent requirements if the State so desires. These standards should significantly strengthen State and local solid waste management controls.

IV REPORT TO CONGRESS

We are now preparing a Report to Congress in response to Section 2202 of the 1987 Marine Plastic Pollution Research and Control Act. This Report will provide important information to ensure that an overall plastics strategy can be developed. We will submit the Report to Congress next June. Some of the areas we will be examining in the Report are: various facets of U.S. production of plastics, characteristics of plastic wastes, impacts of plastics on management of the solid waste stream, and evaluation of potential solutions to the overall problem, including source reduction, use of degradable plastics, recycling, and various other potential solutions.

One section of the Report will deal particularly with that portion of plastics which appear in the marine environment. It will consider not only the types and sources of marine debris as well as its environmental fate and effects. In addition, and highly relevant to the bill introduced by the Chairman, this section will discuss the potential environmental and human health impacts of degradable plastic and any economic, behavioral, or institutional barriers to their use, including potential ways to remove such barriers.

We have established an interagency work group which includes representatives from the Department of the Navy, the Department of the Treasury, the United States Coast Guard, the Food and Drug Administration, the National Oceanic and Atmospheric Administration, and the National Bureau of Standards. The portion of the Report which deals with degradable plastics will be one of the first portions we develop.

The Report will build on the earlier work of an Interagency Task Force on Persistent Marine Debris formed under the auspices of the Domestic Policy Council. Members of the Committee may be aware that the Report of the Interagency Task Force on Persistent Marine Debris, issued in May of this year, offered several recommendations. There were five primary recommendations made by the Task Force, including a recommendation for both federally-sponsored and private sector research on the potential uses for, by-products of, and effects of, by-products of degradable plastic products.

Each of the Task Force's recommendations stated multiple sub-recommendations, which, together, move us in the direction of developing a comprehensive strategy for dealing with plastics. The recommendations for federally sponsored research indicates our need for additional information about degradable plastics. The Task Force concluded that significant data gaps exist in our knowledge of deterioration of degradable plastics in the marine environment, but this gap is also a concern for such plastics in other environmental settings. We need a better understanding of the nature and rates of release of degradation products in the environment among other things. Some degradable plastics, for example, may not perform as intended when buried in soil or when forced below the surface of water after being covered by algae or seaweed. We also need to differentiate between enhanced physical degradation, that is, breaking into smaller pieces, and actual chemical degradation.

These and other questions will be considered in EPA's Report to Congress called for under the Marine Plastic Pollution Control Act of 1987 and the Report being prepared by the Department of Commerce pursuant to Section 2203 of the same Act. EPA will build on the Interagency Task Force's work and will integrate the work on plastics in the marine environment with the overall solid waste management issues related to management of plastic wastes. By doing so we will be better able to provide technical assistance on legislation such as that which we are discussing today.

V EPA'S VIEWS ON S. 2298

S. 2298 expresses the desire of Congress to mitigate solid waste disposal problems while encouraging development of new non-food uses of agricultural commodities. While EPA supports the goals and underlying intent of S. 2298, the Agency opposes enactment of the legislation at this time in recognition of the need to develop a comprehensive strategy for dealing with plastics and to increase our understanding of degradable plastics and their degradation byproducts.

We are concerned with the generation and environmentally sound management of plastics and other solid wastes all over the country--both in terms of achieving an overall understanding of the problems we face in this area and developing a strategy that deals with the whole problem rather than its parts. Therefore, EPA's preference would be to deal comprehensively with the solid waste disposal issues, including the plastics component of those issues, rather than focus solely on the aspects of the problem raised in S. 2298.

When the work currently under way in EPA and other federal agencies is completed to characterize plastics in the waste stream, evaluate current disposal practices, and determine potential environmental effects of releases or by-products from rapidly degradable plastics and potential substitute products, we will be in a much better position to develop an overall strategy.

The availability and desirability of product substitutes and consideration of all improper disposal practices are additional aspects of the Report to Congress we are currently developing in response to the statutory requirements of Section 2202 of the Marine Plastic Pollution Research and Control Act and in the context of the overall municipal waste strategy we will soon publish for public comment. I would also point out that section 6002 of the Resource Conservation and Recovery Act provides EPA authority under existing law to develop procurement guidelines which require federal agencies (and State agencies using federal funds) to adopt preferential procurement policies for products containing recycled materials. We have finalized such guidelines for paper, re-refined oil, and flyash and can do so for products containing recycled plastics at such time as they become available on an acceptable scale. Impacts on the number of products containing recycled plastic available could result from S. 2298, though we cannot predict such a development with any degree of certainty. The relative merits of the two partial solutions to the plastic waste problem--encouraging plastics to be degradable and encouraging recycling--need to be carefully weighed before we encourage one at the potential expense of the other.

VI CONCLUDING REMARKS

In conclusion, I would like to reiterate that completion of the Municipal Waste Strategy, and the Report to Congress and other related work by EPA and other federal agencies currently under way prior to focusing on a particular aspect of the plastics problem would allow us to develop a comprehensive strategy for plastics. In the interim we can work to analyze the effects, both intended and unintended, of laws and policies enacted at the State level which encourage the use of degradable plastics for certain products. We stand to gain valuable knowledge by determining the most effective implementation strategies used by the States, and can look at their potential applicability to achieving our shared overall goal of reducing plastic pollution in the environment--a goal which, in part, is represented by S. 2298.

This concludes my prepared remarks. I would be happy to respond to any questions you have at this time.

Statement of Robert W. Long
Deputy Assistant Secretary
Science and Education
United States Department of Agriculture
Before the Committee on Governmental Affairs
United States Senate
September 20, 1988

Mr. Chairman, I appreciate the opportunity to appear before you and the Members of the Committee today to discuss activities of the U.S. Department of Agriculture as they relate to S. 2298, the "Agricultural Commodity-Based Plastics Development Act of 1988."

I have brought with me Dr. William M. Doane of the Agricultural Research Service. He is the Research Leader at the Plant Polymer Laboratory in Peoria, Illinois.

You have expressed your interest in the research and development programs of USDA regarding new non-food uses of agricultural commodities, the total amount spent on this research, the types of products ready for commercialization and their estimated costs, and the economic projections of the amount of corn and other commodities that could be utilized by these products.

One way to expand the farmer's market is to develop industrial uses for farm products. The terms "industrial market" and "industrial uses" however, have come in recent years to have a narrower, special meaning. Traditionally, the farmer has produced raw materials for food, fiber, and shelter. That is still his main business. But our highly complex civilization also provides a rapidly expanding market for other goods in bewildering variety, ranging from cosmetics to airplanes. Human wants for these things have no discernible limit. To what extent does the farmer supply the raw materials for the industries based on these new wants, and what are the possibilities of expanding his proportion of that market?

Mr. Chairman, the previous paragraph of my statement is rather significant in relationship to the USDA's research and development program for new non-food uses of agricultural commodities. That statement was contained in the Yearbook of Agriculture in 1940, entitled, "Farmers in a Changing World." Forty-eight years later, the world of the farmer is still changing. But today, that world is changing more rapidly.

Some of the earlier "new technologies" are causing present-day problems. For instance, the development of plastics made possible the mass production of thousands of items which are available to consumers. We live in a society where disposable plastic items are commonplace. Yet, the problem we have is that most of these disposable items end up in ever-growing landfills where they remain remain virtually intact for decades. Or, they end up on the roadsides, in streams or in our oceans.

All of these plastic products are derived from petroleum-based raw materials imported mainly from foreign countries. Today, as the result of extensive research both in the public and private sectors, we do have the ability to produce biodegradable plastic products. And, the Agricultural Research Service is rightfully proud of the role which it has played in developing such products.

I want to cite for you today a few examples of the work of ARS:

ARS, at the Northern Regional Research Center in Peoria, Illinois, has conducted basic research over the last several years to develop technology for the incorporation of starch from corn or wheat into plastic film. In addition to providing new markets for starch, the objective was to provide the agricultural mulch film that would degrade sufficiently during the crop growing season so that removal of the film before planting next year's crop would be unnecessary. Growers currently spend $100-200 per acre for film removal and disposal.

The research has been most challenging to provide polyethylene (the highest volume plastic) films containing high levels of starch, since polyethylene and starch are totally incompatible. Our research to date has been partially successful in that a technology has been developed to provide one type of starch-based plastic film. This technology has been patented, and an exclusive license has been granted. The licensee has been conducting the necessary developmental research during the last year, and will market their first commercial, starch-based plastic film this year.

In addition to the technology developed by ARS, some earlier technology out of England to incorporate low levels of starch into plastic grocery bags is now being used to provide starch-containing polyethylene bags. During the past years, a few U.S. companies have started using this technology to produce specialty bags containing low levels of starch.

ARS is continuing research on starch-based plastics to meet three objectives:

The first is to develop technology for providing starch-plastic films containing high levels of starch with properties acceptable for broad market usage. The second objective is to develop technology leading to starch-plastic compositions acceptable for molding applications. Several different plastic resins are used for multi-billion pound production of plastic molded articles.

The final objective is to establish the rate and extent of microbial degradation of plastics containing starch.

Successful achievement of objectives one and two would provide the improvement needed in starch-based plastic compositions and possibly open up large new multi-billion pound markets for starch. Achievement of objective three would provide a relatively simple and standard technique for measuring microbial degradation of these systems. Since no evaluation technique now exists, the claims of biodegradability being made for any plastic containing starch are most often overstated and misleading.

Just briefly, let me outline some additional examples of the type of research being conducted by ARS in this area of non-food uses.

From soybean oil, useful products are being made. For example, printer's ink at present requires 300 million pounds per annum of petroleum-based oil; a soybean oil substitute would use about 25 million bushels/year of U.S. soybeans. Biotechnological research is being applied to provide hydroxy acids from soybean oil and replace imports of castor oil (100 million pounds/year). Novel catalysts are being investigated for preparing lauric acid (for the detergents and lubricants industry) with the view of replacing coconut and palm kernel oil imports. Soybean oil is being developed as a fuel for farm tractors; also to make cosmetics, specialty lubricants and other higher value products.

Lactose from the dairy industry is being upgraded, through fermentation systems to health care products. Experiments in which milk proteins are cross-linked have lead to the manufacture of thin, durable, and biodegradable films for packaging.

There are projects for improving cotton products. Modifying the internal crystalline structure of cotton fibers has resulted in better processing and utilization characteristics. Wrinkle-resistant fabrics amenable to dyeing have been made. Distinctive thermal storage properties have been built into cotton fibers using special polymers.

The conversion of hides to leather is being optimized, for example, by finding out how salts interact with the tanning process in leather manufacture. By removing grease, vegetable matter, stains, and dark fibers, the quality of U.S. wool is being improved.

Bioprocess systems are being developed to synthesize biocontrol products such as fungal spores, which attack weeds. These biopesticides, environmentally benign, are expected to substitute in the future for a considerable slice of the $15 billion pesticide market. In ARS research work, they are being manufactured through fermentation systems based on carbohydrate substrates from agricultural commodities.

Imports of natural rubber to the U.S. amount to about half a million dollars worth per year. These imports are from tropical countries. To develop a U.S.-based source of natural rubber, the ARS has set up two projects in collaboration with industrial partners. These projects are of a somewhat different nature. One involves the development of guayule as an arid-zone c
The other is based on bioreactor systems; one approach is to use bacteria engineered genetically to synthesize rubber in a fermentation process usin
carbohydrates such as lactose and starch as feedstock; the other is an immobilized enzyme reactor.

ARS research funding for the total program on non-food uses is approxi
million.

Mr. Chairman, I am aware of your questions regarding economic projections on the amount of corn and other commodities that could be utilized by new products. However, at this stage in our research program, we are not prepared to issue such projections. It should, however, be quite obvious that the potential economic value would be significant.

I would now like to address some of the specific provisions of S. 2298. USDA will defer to the General Services Administration and to the Environmental Protection Agency on the provisions of that portion of the bill dealing with the cataloging and purchasing of biodegradable products. However, we do not support appropriating $20 million annually to pay the difference in costs between conventional products and degradable plastic products. Agencies purchasing the new products should be willing to use their regular appropriations to purchase such products as well as the Administration's overall position on the bill.

Section 8 would require the Secretary of Agriculture to report to the Congress as to the research and development on new uses for agricultural commodities. We can and do provide the information requested in this section. We will continue to provide such information as you may request.

Mr. Chairman, USDA shares your interest and concern for the development of new agricultural products. We have a long history in this regard, and we will continue these efforts on behalf of the American farmer and consumer. Thank you for giving us the opportunity to appear before you and the Members of this Committee today. We would welcome the opportunity to respond to your questions.

Testimony of Mr. Steve Wentworth
First Vice President of the National Corn Growers Association
Before the Senate Committee on Government Affairs

Mr. Chairman, members of the Committee, I am Steve Wentworth, First Vice President of the National Corn Growers Association and a farmer from Oreana, Illinois. I appreciate the opportunity of testifying today on S. 2298, the "Agricultural Commodity-Based Plastics Development Act of 1988". My comments will address two areas: the efforts by the National Corn Growers Association in finding new uses and new markets for corn specifically the potential of corn-based degradable plastics and the importance of S. 2298.

New Uses and New Markets for Corn

The National Corn Growers Association (NCGA) has made a long-term commitment to developing new uses and new markets for corn and corn products. While growth in the established markets, exports, animal feeds, ethanol, and sweeteners, is encouraging and important, vast new industrial uses offer even more hope for the future.

In June of last year, the first National Corn Utilization Conference was held in St. Louis, Missouri. The conference sponsored by the NCGA brought together over 250 scientists, researchers, industry specialists, and producers for a closer look at the potential for new industrial uses for corn.

I would like to bring you up to date on two in which we are using our renewable resource - corn - to help solve environmental problems facing our nation while at the same time providing a new market for corn: degradable plastics and calcium magnesium acetate.

Degradable Plastics

Many local and state governments are facing a crisis regarding solid waste. Annually, 150 million tons of municipal solid wastes are generated nationwide. Ninety percent of our urban waste is buried. The U. S. Conference of Mayors estimates that half of the American cities will be out of landfill space in ten years. It is estimated the Chicago metropolitan area has four years remaining and New York City has five years left in its landfill. In 1960, the average American produced 2.9 pounds of garbage per day. Today, it has increased to 5 pounds per day. In 1985, there were 75 million tons of waste in throwaway containers that did not exist 40 years ago. Plastics represent 7 percent by weight and 30 percent by volume of solid wastes buried in our landfills.

It is here, the plastics segment of solid wastes, where agriculture can play a role. Degradable plastics, a blend of corn starch and synthetic polymers, can be part of the solution to our solid waste problem.

At the six percent level, corn starch can be added to plastic along with an oxidant, which can be corn oil, to render common plastics degradable (such as garbage bags) without any drastic reduction in physical characteristics. Once in contact with the biological media -- initially fungi and then bacteria -- in soil or water, the corn starch granules are consumed. This opens up and weakens the matrix of the material. Then the oxidant, corn oil, in contact with the metal salts (copper, iron) in the environment forms peroxide, which breaks down the long polymer chains. Once these carbon chains are shortened, they become a food source for biological activity. It is estimated that in a landfill one of these plastic bags would begin to degrade in six months. This depends on the environment to which the plastic is exposed. It can be controlled by the ratio of catalyst and stabilizer. Typical times required to cause a plastic film to lose 90 percent of its mechanical properties can be adjusted from a number of days at 70 degrees C to 6 months at ambient soil burial conditions. The products which may be released from degradable plastics are the same products that would be released by the slower degradation of the same conventional plastic. As these bags degrade much faster than the current conventional garbage bags, the wastes contained in the bag also decompose that much faster.

The city of Lincoln, Nebraska and the Nebraska Corn Development, Utilization and Marketing Board have joined together in a degradable plastic demonstration project. Some 1,400 Lincoln residents were asked to place their yard waste in specially marked degradable bags that contain six percent corn starch. These bags containing yard waste will then be processed into compost, which will allow more efficient use of the city's new landfill site.

If this project was used for all of Lincoln's yard waste, it is estimated degradable bags could potentially save the city $100,000 in costs and lengthen the life of the landfill.

The State of Illinois will enact legislation, in November, sponsored by State Senator Jerome Joyce and State Representative Philip Novak which creates space in existing Illinois landfills while providing a new use for corn. Beginning in July of 1990, landfills that accept landscape waste will be required to compost such material in degradable bags such as plastic bags containing corn starch. This will be the largest program enacted by any state.

This past spring in Page, Arizona, the Salt River Project, an Arizona power and water utility, sponsored its annual clean-up project. This year, the volunteers were using corn-starch based degradable plastic garbage bags to clean up the area around Lake Powell. Half a million bags were distributed this year in Arizona with a logo on the bags indicating they are degradable -- made with corn, a renewable resource.

We feel the degradable garbage bag is the first step in offering a solution to our solid waste problem. But, we also need to look long term at developing other degradable plastic products where applicable. Plastic products, such as milk jugs, oil bottles, food trays, foam cups, and polystyrene containers are currently in the final testing stages to be made degradable and are moving rapidly toward commercialization. Additionally, research needs to be continued to improve and expand the use of corn starch in the many plastic products we use. It is estimated that potentially a 150 - 300 million bushel market for corn could be created through the use of degradable plastics.

Calcium Magnesium Acetate

Annually we use close to 10 million tons of salt for highway de-icing. However, salt has detrimental effects of corrosion, and damage to road surfaces, automobiles, vegetation, and water supplies.

One alternative to salt is calcium magnesium acetate (CMA). Most of the studies indicate that CMA performs as well as salt but is 10 times less corrosive, has little detrimental effect on vegetation and wildlife, and does not lower water quality. The drawback is it costs about ten times as much as salt.

CMA can be produced using either petroleum or corn as the feedstock. However, additional research is needed on production, testing, economic analysis, and market development. It is estimated if CMA made from corn captured 10 percent of the highway salt market, this would mean a 60 million bushel corn market annually.

These are just two examples of the many efforts that the NCGA are working on to use our renewable resource - corn - to help solve environmental problems facing our nation while at the same time providing a new market for corn.

Currently, the drought is on everyone's mind. Will there be enough supply? Will the United States have to import certain agricultural needs? We only have to review history. The same questions were asked in 1983. Then two years later, we were discussing record breaking surpluses.

New product development and market introduction is a long, arduous, and expensive process. It requires commitment, discipline, and persistence.

We need a long term and consistent national commitment in the development of new agricultural products for industrial uses. The federal government needs to increase the amount of research dollars for utilization research. We need to provide a means to take our research and technology from the laboratory to the marketplace.

S. 2298, the "Agricultural Commodity-Based Plastics Development Act of 1988" helps in this effort. By promoting the development of degradable plastics markets from agricultural based products and providing the incentives for further technology development we will be able to increase our efforts in the private sector. Also, the establishment of an interagency working group will help provide the coordination and cooperation that is needed in developing a national program. The effort of utilization research and market development needs private and public cooperation.

The development of new industrial uses and markets from our renewable resources, agricultural products, will provide for a viable agricultural economy in the future. It will also help establish new industries, employment and economic activity for our communities. And it will also help us to be competitive in the world marketplace.

Mr. Chairman, the National Corn Growers Association commends you for your efforts and looks forward to working with you and the Committee.

TESTIMONY OF THE AMERICAN SOYBEAN ASSOCIATION
PRESENTED BY
WAYNE BENNETT, CHAIRMAN
BEFORE THE
SENATE GOVERNMENTAL AFFAIRS COMMITTEE
UNITED STATES SENATE
SEPTEMBER 20, 1988

re: ALTERNATIVE USES FOR SOYBEANS AND SOYBEAN PRODUCTS

Mr. Chairman, I'm Wayne Bennett, a soybean farmer from Lonoke, Arkansas. I'm Chairman of the American Soybean Association (ASA), a national non-profit organization representing U.S. soybean farmers with members in 29 states. ASA seeks to increase the opportunity for U.S. farmers profitability through its market development, research, government relations and trade policy.

ASA appreciates the opportunity to appear before the Senate Governmental Affairs Committee today to discuss alternative uses for soybeans. As most people are aware, the major products made from soybeans are soybean meal, a high protein concentrate used in livestock and poultry feeds, and soybean oil, a vegetable oil low in saturated fatty acid content used in food processing. However there are other uses for soybeans such as soy flour, varnish, make-up, and paint. Two of the most promising alternative uses which I will focus on in the remainder of my testimony are soybean oil-based ink and soybean oil used as a dust suppressant.

The American Newspaper Publishers Association (ANPA) initiated the development of soybean oil-based ink, replacing the petroleum carrier with soybean oil. The nation's newspapers have, for years, been printed with an ink which closely resembled the oil used in an automobile, combined with carbon black or color pigment. This ink was originally formulated with approximately 60 percent to 80 percent petroleum oil products and 12 percent to 20 percent pigment plus binder and/or resins depending on the printing press on which it was to be used.

The product remained the same for many years until the first oil shortage occurred in 1974. The oil shortage caused a change in the supply of ink oils, which caused printing problems and some unwanted odors in newspaper inks. During this period of time, the newspaper business was also experiencing a change in technology. Newspaper presses were rapidly being converted from letterpress (relief type printing) to offset (planographic type printing) due to quality and environmental demands. After the oil crisis of 1974 passed, inks again stabilized until the problem reoccurred in 1979. It was at that time ANPA began research into alternative oils for newspaper inks. Their results indicated that soybean oil could be a viable alternative to petroleum-based ink.

The product which resulted from the ANPA test contained about 60 percent alkali refined soybean oil, a resin, a pigment and an antioxidant. The viscosity and pigment dispersion was adjusted to particular press configurations by changing the amount of soy oil and resin.

Since the original formulations of soybean oil-based ink were developed, a number of improvements have been made. Some of the original resin has been replaced with a blown soy oil. Some intermediate viscosity soy oil is being used as a viscosity adjustment vehicle. Additionally, some black ink has been produced using non-refined soy oil with success.

Advantages of soybean oil-based ink include:

- Soybean oil is readily available at competitive prices for color inks and at consistently high quality.
- Soybean oil-based ink has less "rub-off" and gets better "mileage" (compared to petroleum-based products, more copies can be printed at the same printing density per pound of ink) on the press.
- Soybean oil is biodegradable and should be environmentally safe, thus reducing disposal problems.

Mr. Chairman, allow me to expand on the environmental issues surrounding soybean oil-based ink. Currently disposal of waste petroleum products is getting more difficult and expensive. Waste ink is normally mixed with solvents such as kerosene for press wash-up and stored in barrels and hauled away. Landfills are no longer a source of disposal and incineration or recycling is difficult and expensive. Since soybean oil is a vegetable oil, it is much easier to handle and could be a totally biodegradable product if the correct solvents are used in wash-up and if a biodegradable resin is developed. Research into these areas are currently underway. ASA strongly encourages Congress to assist in funding research which will expedite the development of a product which will be completely biodegradable, thus bettering the environment. Congress should also consider funding research to facilitate the use of soybean oil-based ink on glossy paper (i.e. magazines). Currently it cannot be used for heat-setting on glossy paper; not as a result of any inherent difficulty with the oil, but because no formulas have been developed yet. This would be a new field of research for the product.

Over 500 newspapers in this country are currently using soybean oil-based ink. Color pictures printed in soybean oil-based ink are winning the major photo contests because soybean oil-based ink provides a clearer, sharper reproduction. All of the above factors combine to show that the product is successful and that the potential market is staggering. It is estimated that approximately 66 million gallons, or 440 million pounds of oil, is used in the ink industry to make letterpress and offset ink. Newspapers use about 80 percent of that quantity, and soybean oil could be the predominant vehicle used in inks in the near future. Even though black soybean oil-based ink may cost more than petroleum-based black ink, ASA is optimistic that since the ink measures up technically the demand for quality will override cost considerations since ink represents only 1 percent to 2 percent of newspaper's printing costs. Moreover, some of the higher price could be offset be wider coverage ("milage"), easier waste disposal, and less "rub-off", all of which may allow publishers to increase circulation.

Senator Paul Simon (IL) and Representative Vin Weber (MN) are the first two Members of Congress to print their Congressional newsletters using soybean oil-based ink. ASA encourages other Members to do the same. We further believe Congress should encourage the General Printing Office to seriously consider using soybean oil-based ink for all printing services contracted outside the agency as well as "in-house" printing projects. The Congressional Research Service has responded favorably to this position.

Turning now to the use of soybean oil as a dust suppressant. For decades the American grain industry has been searching for effective solutions to the problems created by grain dust in elevators and processing facilities. In 1977, the U.S. Grain Marketing Research Laboratory began laboratory-scale, pilot-scale, and limited commercial-scale studies to determine the feasibility of adding minute amounts of oil to a moving grain stream in order to reduce dust emissions. The success of these tests indicated that an appropriate oil-additive system could effectively reduce dust concentrations inside a commercial grain elevator, thereby reducing the risk of explosion, health, and environmental safety hazards.

The use of edible oils to reduce dustiness of grain during handling dates back to 1951, when Moen and Dalquist patented the use of an oil emulsion for this purpose. They found that applying 300 ppm to 800 ppm of mineral oil to grain effectively reduced dust emission in subsequent handling. The same technique has been used to control dust in other operations. For example, it has been common practice for many years to use lecithin to suppress dust in feeds. Research in the field of agriculture has shown that additives with an oily consistency can significantly reduce dust levels generated during processing of cotton.

Laboratory tests by Lai et al. (1981) have shown that application of either mineral oil or Durkex 500, a hydrogenated and fractionated soybean oil, at 600 ppm effectively reduced the dustiness of corn and wheat. As little as 150 ppm to 200 ppm (1 to 1-1/2 gallons of oil per 1000 bushels of grain) was effective in reducing almost 100 percent of grain dust for 1 to 3 months. At a 600 ppm application, dust control was maintained for about 6 months. The applied oils had no effect on test weight, moisture content, or rancidity. In addition, they had no effect on the insecticidal activity or persistence of malathion applied to wheat or corn.

Application of soybean oil requires standard equipment that can be obtained locally. Any spraying method of application is suitable as long as the amount of soybean oil being applied can be controlled and as long as the grain is thoroughly mixed following application. ASA studies suggest spraying the oil on a moving grain stream as it is falling or being agitates, such as immediately before going into the auger.

In summary, researchers have found that a dust suppression system which uses soybean oil has several advantages, including:

* It can be installed for an average cost of $1,000 to $3,000, exclusive of oil storage, which is a significant cost savings over mechanical dust collection.

* At most, only a minimal back-up dust collection system, such as a cyclone, is needed.

* Soybean oil keeps equipment and facilities cleaner which reduces maintenance and housekeeping.

* It improves worker health, attitude and safety.

* A cleaner plant improves housekeeping ratings and in some cases lowers insurance rates.

* Less grain is lost as dust in processing.

* Soybean oil has the approval of the Federal Grain Inspection Service and the Food and Drug Administration.

Applying soybean oil to livestock and poultry feed has also been shown to significantly reduce the amount of airborne dust in the feed. In fact, research indicates adding just 2 percent soybean oil cuts dust by 98.6 percent. Dust is potentially dangerous, not only as a carrier of pathogenic microorganisms, but because of it's direct adverse effect on the respiratory tract of livestock and people. Ongoing human health research by Dr. Kelly Donham at the University of Iowa shows that breathing confinement hog dust long-term can cause health problems for humans similar to cigarette smoking.

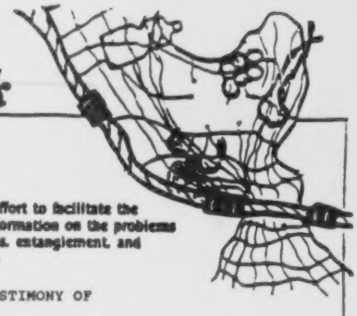
Reducing feed dust saves wear and tear on machinery and increases the efficiency of ventilation systems. The addition of soybean oil improves growth, feed efficiency, and average daily gain of livestock and poultry because of the added energy that soybean oil provides and because less feed is lost in dust. Soybean oil added to a sow's ration helps a farmer wean more pigs and improve milk quantity and quality. Soybean oil also reduces feed particle segregation and improves palatability.

These are just two new uses for soybeans. In both cases, the soybean oil market demand is affected. It is important to realize that for every 1 cent increase in the price of soybean oil (10.7 pounds of soybean oil is produced per bushel of soybeans) the soybean farmer realizes an 11 cents per bushel increase in the price of soybeans. An income increase derived, not from the federal Treasury, but the open market.

The soybean industry today faces new challenges as researchers attempt to develop new uses for soybeans. American soybean farmers check-off about $3.54 million of their sales annually to assist in funding research aimed at promotion and the development of new uses for their products. Soybean farmers feel that market development both domestic and abroad for traditional and new products is vital to their survival. With the continued research investment, made in a cooperative nature by farmers, universities, and the federal government, more new industrial and food uses for soybeans and soybean products will be forthcoming. Additional federal resources, however, should not be at the expense of existing production and utilization research, but should be as a result of increased federal research expenditures.

Once again, thank you Mr. Chairman for the opportunity to discuss this exciting area with the Committee. I'll be happy to try and answer any questions the Committee has.

The Entanglement Network



A cooperative effort to facilitate the exchange of information on the problems of marine debris, entanglement, and incidental take.

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American Cetacean Society
American Humane Association
Animal Protection Institute of America
California Marine Mammal Center
Center for Coastal Studies
Center for Environmental Education
Cetacean Society International
Defenders of Wildlife
Environmental Defense Fund
Friends of Animals
Friends of the Sea Otter
The Fund for Animals
Greenpeace
HEART
The Humane Society of the United States
International Wildlife Coalition
Maine Audubon Society
National Consortium
National Audubon Society
Natural Resources Defense Council
The Oceanic Society
Society for Animal Protection Legislation
Whale Center
World Wildlife Fund

TESTIMONY OF

DEFENDERS OF WILDLIFE
AND
AMERICAN CETACEAN SOCIETY
AMERICAN HUMANE ASSOCIATION
AMERICAN SOCIETY FOR THE PREVENTION OF CRUELTY TO ANIMALS
ANIMAL PROTECTION INSTITUTE OF AMERICA
CALIFORNIA MARINE MAMMAL CENTER
CENTER FOR COASTAL STUDIES
CENTER FOR ENVIRONMENTAL EDUCATION
CETACEAN SOCIETY INTERNATIONAL
COMMITTEE FOR HUMANE LEGISLATION
EARTH ISLAND INSTITUTE
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GREENPEACE USA
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INTERNATIONAL FUND FOR ANIMAL WELFARE
INTERNATIONAL WILDLIFE COALITION
LIVING OCEAN SOCIETY
LONG TERM RESEARCH INSTITUTE
MAINE AUDUBON SOCIETY
MASSACHUSETTS SOCIETY FOR THE PREVENTION OF CRUELTY TO ANIMALS
NORTH WIND UNDERSEA INSTITUTE
THE OCEANIC SOCIETY
SIERRA CLUB WILDLIFE COMMITTEE
SOCIETY FOR ANIMAL PROTECTIVE LEGISLATION
SUNCOAST SEABIRD SANCTUARY
TEXAS ENVIRONMENTAL COALITION
THE WASHINGTON HUMANE SOCIETY
THE WHALE CENTER
AND
WORLD WILDLIFE FUND

ON BEHALF OF THE ENTANGLEMENT NETWORK COALITION
REGARDING SENATE BILL 2298
REQUIRING
THE ADMINISTRATOR OF THE GENERAL SERVICES ADMINISTRATION
TO ENCOURAGE THE DEVELOPMENT AND USE OF PLASTICS
DERIVED FROM CERTAIN COMMODITIES,
AND TO INCLUDE SUCH PRODUCTS IN
THE GENERAL SERVICES ADMINISTRATION INVENTORY
FOR SUPPLY TO FEDERAL AGENCIES,
AND FOR OTHER PURPOSES.

Before the Senate Committee on Governmental Affairs.

September 20, 1988

Presented by:

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Introduction

Mr. Chairman, Members of the Committee, thank you for the opportunity to testify here today. I am Dr. Albert M. Manville, Senior Staff Wildlife Biologist for Defenders of Wildlife, and Chair of the Entanglement Network Coalition (Network). This testimony is being presented today on behalf of the American Cetacean Society, the American Humane Association, the American Society for the Prevention of Cruelty to Animals, the Animal Protection Institute of America, the California Marine Mammal Center, the Center for Coastal Studies, the Center for Environmental Education, the Cetacean Society International, the Committee for Humane Legislation, Defenders of Wildlife, Earth Island Institute, Friends of the Sea Otter, the Fund for Animals, Greenpeace USA, HEART, the Humane Society of the United States, the International Fund for Animal Welfare, the International Wildlife Coalition, the Living Ocean Society, the Long Term Research Institute, Maine Audubon Society, the Massachusetts Society for the Prevention of Cruelty to Animals, the North Wind Undersea Institute, the Oceanic Society, the Sierra Club Wildlife Committee, the Society for Animal Protective Legislation, the Suncoast Seabird Sanctuary, the Texas Environmental Coalition, the Washington Humane Society, the Whale Center, and World Wildlife Fund which are members or participants in the Network. The Network is a consortium of some 40 conservation, wildlife, and animal protection organizations which serves as the unified voice of the environmental community on entanglement, incidental take, and debris ingestion -- problems resulting in injury and death to living marine fish and wildlife by capture in or ingestion of plastic (see beyond). Combined membership in the groups represented in the Network totals more than 10 million American citizens.

As you are well aware, the 100th Congress made significant first-ever strides in dealing with the dilemma of burgeoning plastic debris in the marine environment through passage of the Plastic Pollution Control Act of 1987 (H.R. 3674; later P.L. 100-220, Title II). This law deals with a number of measures intended to reduce and ultimately eliminate plastic pollution, particularly in the marine environment. Two major gaps in this law are the lack of requirements for **degradability** in certain types of plastic, and the lack of comprehensive plastic **recycling** requirements. The former topic is, of course, the subject of this hearing today.

The House of Representatives is currently considering a bill introduced by Representative Studds (H.R. 5117) which would require the use of degradable materials in beverage container connector rings. The Senate has already passed companion legislation to H.R. 5117 by unanimous consent (S. 1986). Representative Lancaster has introduced another bill (H.R. 5193) which sets up a schedule and program for banning non-degradable plastic storage containers, diapers, shopping bags, packing material, and other products within five years. Senator Harkin has also introduced a bill (S. 2355) which would require a study and report on the use of degradable plastic by the Department of Defense.

Representatives Courter and Hochbrueckner have each introduced legislation addressing the need for recycling. H.R. 4454 would establish programs to promote recycling, while H.R. 5000 is designed to encourage recycling research and the development of recycling technologies, respectively.

The Bill before you today, the Agricultural Commodity-Based Plastics Development Act of 1988 (S. 2298), addresses not only the problems our country is currently facing with regard to the proper disposal of its plastic waste, but also problems concerned with agricultural production. The Bill would require that the General Services Administration (GSA) identify the products in its purchasing inventory, "... that can be made from degradable plastics technology, that are environmentally safe, with particular emphasis on agricultural, commodity-based products". Next, the GSA must set up a sliding scale standard for preferential procurement of those products based upon, "... (A) the increased market for agricultural products, (B) the benefits to the environment, and (C) the benefits to the long-term energy independence of the United States" (Section 4(c)(2)).

DISCUSSION

For the hearing this morning, I have been asked to provide our views on:

- growing environmental problems faced by the federal government, states, and localities concerning solid waste management;
- the potential contribution of degradable plastics in meeting this challenge; and
- the role of the federal government in addressing these problems.

The Problem: Plastics and Their Impacts on Fish and Wildlife

The United States, with approximately 6 percent of the world's population, utilizes some 36 percent of the world's resources. Our production and use of plastic continues at a near exponential rate, with 53 billion pounds of plastic sold in the U.S. in 1987 alone and climbing. As a result of this massive use, we presently dispose of some 700,000 tons of plastic into our oceans each year (1). To deal with this plastics problem will require, in addition to the legislation passed last year and pending legislation this year, a multifaceted approach including recycling, waste reduction, return to biodegradable nonplastic alternatives, enforcement on dumping, and the use of degradable plastic -- the latter option the subject of this hearing.

Of special concern to the members and participants in the Network is the impact of plastic debris on fish and wildlife, especially those in the marine environment. Plastics kill, debilitate, maim, and injure marine mammals, seabirds, sea turtles, fish, and other marine life through entanglement, incidental take, or debris ingestion. **Entanglement** refers to the capture, entrapment, and often death of animals in lost or discarded plastic debris, including fishing nets (so called "ghost nets"), net fragments, packing bands, six-pack yokes, and other items. Those nontarget species captured in active fishing nets, seines, trawls, or related equipment are termed **incidental take**. **Debris ingestion** is a third major problem for marine organisms. Raw plastic particles and the breakdown products of finished plastic items such as styrofoam cups are mistakenly ingested by numerous seabird, mammal, turtle, and fish species (2).

Conservative estimates indicate that over 100,000 marine mammals, 1 million seabirds, thousands of sea turtles, and untold numbers of fish die annually due to entanglement in a variety of plastic debris. Add to this at least another 1 million seabirds, 120 thousand porpoises, 45 thousand sea turtles, and millions of fish killed incidentally in trawl nets, purse seines, gillnets and other active fishing gear. At least 50 species of seabirds are known to ingest plastic, likely mistaking pellets for fish eggs. Documentation of plastic ingestion by fish is growing. Sea turtles commonly ingest plastic bags, probably mistaking them for jellyfish, a favorite food. Even great whales ingest plastic. In many cases, it may be lethal (1, 3).

In late July, I returned from a 10-day survey of some of our most remote islands in North America, the outer Aleutians. Attu, our western-most island, is located some 1,600 miles west-southwest of Anchorage, Alaska. During the trip, 25 beach surveys were conducted on 7 islands. The amount of plastic uncovered during this investigation was truly astounding, with materials identified from Japan, Korea, Mainland China, Taiwan, Russia, Norway, and the United States. Although trawl nets were common plastic items, Wrangell Beach on western Attu Island contained some 511 individual plastic items of 27 different types in one 100-yard portion of the beach surveyed. In addition to the discovery of hundreds of dead seabirds -- some wrapped in plastic -- a precipitous decline in the Steller's sea lion population was noted on Attu Island. Plastic may indeed be taking its toll.

The Plastics' Dilemma

Aside from the impacts of plastics on fish and wildlife, recent articles in Time magazine (4) and Newsweek (5) discuss in detail the growing environmental problems faced by local, state, and federal governments concerning solid waste management. You, of course, have probably all heard of the problems with plastic syringes, blood containers, crack vials, plastic tampon applicators, and other alarming types of plastic debris washing up on New York, New Jersey, Maryland, and Florida shores as well as elsewhere this summer. But a far more comprehensive and overridingly serious problem involves our rapidly diminishing waste disposal facilities.

By 1990, over half our landfills will be at or exceeding saturation. Because of space constraints, ground water contamination, disease, leaching, toxics, odors, and other problems, landfills will begin to close down in the very near future. On Long Island, New York, for example, all landfills there will be closed by 1990. And with the "not in my backyard" (NIMBY) syndrome, citizens don't want new landfills or incinerators sited in their communities (6). So how do we deal with these problems?

The burgeoning plastics' problem can be dealt with in several ways, including:

- **waste reduction**: a mind-set we soon are going to have to get into, especially since "out of sight" no longer means "out of mind;"
- **recycling**: next to and as part of waste reduction, likely our most important tool in dealing with plastics (and other wastes, for that matter);
- **landfilling**: rapidly becoming an unacceptable alternative because of space, contamination, leaching, etc.;
- **incineration**: an unacceptable alternative not only because of concerns over release of dioxins, furans, and heavy metals in fly ash, but the continued further addition of CO2 into the atmosphere adding to the "greenhouse effect;"
- **composting**: a novel but only partial solution to elimination of degradable plastics, space constraints being a major limiting factor (see beyond); and
- **use of alternatives to plastic**: such as fiber-based products including paper, cardboard, hemp, cotton, etc.

Although radical in concept, the federal government needs to begin seriously considering placement of a limit on the amount of virgin plastic produced and sold in this country. Most plastic is generated from petroleum, a limited, nonrenewable resource. The Harvard Energy Institute, for example, estimates that we'll run out of petroleum worldwide around 2020, based on current and projected future use. We presently waste millions of gallons of fossil fuels on throwaway plastics each year. To reduce the need to continue generating petroleum-based plastics at a near exponential rate, several options are available:

- **recycling**: which states like New Jersey are now mandating, and which Congress is considering through several other bills;
- **nondegradable plastic reduction**: through use of degradable plastics, made in part from non-petroleum-based products (e.g., cornstarch plastic) to wholly non-petroleum-based plastics made from glucose (e.g., PHBV) or chitin (e.g., chitosan-derived plastic produced from tremendously abundant shellfish waste); and

- **use of nonplastic alternatives:** such as paper, cardboard, and other cellulose fiber-related products.

Degradable Plastic as an Option

While we in the Entanglement Network recognize that passage of this legislation will not solve our plastics' solid waste problem, it is part of the equation -- and part of the solution -- which must be considered. Passage of this bill will also send a further message to the plastics' industry, product users, and the general public that Congress considers degradability a viable option in dealing with the plastic refuse problem, and that Congress is especially concerned about the impacts of plastic on fish and wildlife resources. Passage of this legislation will also enable the federal government through a myriad of products supplied by the GSA to set an example both nation- and worldwide that degradability is one part of the solution in dealing with plastic waste.

Late last June, 9 environmentalists (all from the Network), 5 Congressional staff members, and 10 Navy personnel released a report detailing recommendations to the Navy on how the overboard disposal of plastics could best be eliminated in the next 5 years (7). Although nonplastic alternatives and degradable plastics were recommended as options for the Navy, the GSA should consider our recommendations government-wide, and not just for the Navy. The report, in fact, should be used as a model by GSA not only for research and possible implementation of degradable technologies, but also as a tool for help in reduction of the myriad of plastics used in the many facets of the federal government system. A copy of that report is appended to this testimony.

Concerns Over S. 2298 and Recommended Improvements

Members of this Committee must be cognizant of "quick fixes" and apparent readily available solutions to nondegradable plastic problems, including those in the form of cornstarch-based plastic. Preliminary results indicate that agricultural commodity-based plastics can be produced which degrade in the environment under certain conditions, including composting. However, buried in a landfill under anaerobic bacterial conditions, or little or no bacterial activity at all, they may break down no faster than everyday nondegradable plastic products. In essence, landfilling (as we currently know it) of degradable plastics may not be the answer.

To deal with the problem, and questions about degradation of biodegradable plastics -- including cornstarch-based, PHBV, chitosan-derived, and other biodegradable plastics -- we recommend that language be included in the Bill which specifically calls for further research into degradability of these plastics:

- on the land, on the topsoil;
- in shallow landfills under active microbiological conditions at elevated temperatures and humidity;
- in deep landfills;

- following shredding under the aforementioned conditions; and
- when shredded and composted.

Cost of this research would be covered through the annual $20 million appropriation ceiling provided in the Bill. Where research in these areas has already been conducted, we recommend that those results be compiled and presented to Congress, including the additional results from studies on the aforementioned areas.

In regard to the testing of biodegradable plastics at sea, there is a clear need to determine if the biodegradable plastics degrade successfully in the ocean, and at what rate they degrade. We note that the ability of plastics to degrade in the marine environment should not serve as a justification for the disposal of such materials at sea, since damage to wildlife may occur prior to completion of the degradation process. However, language needs to be incorporated into the Bill which calls for this research, along with a report to Congress on the results. In technologies which employ a low molecular weight additive in the plastic resin, degradation must be tested to assure that the introduction of additives by leaching are not deleterious to the marine environment or to living marine organisms (8). In fact, this Bill should call for the **establishment of government standards** for the testing of all degradable plastics and non-plastic alternatives to make certain they degrade as reported.

In one study by the United States Testing Corporation, Kraft paper grocery bags -- subjected to a microbiologically active soil at elevated temperatures and humidity -- deteriorated in about 7 days, while polyethylene plastic bags showed no visible signs of deterioration by the end of 28 days, although tensile strength had decreased by 30 percent (9). In another study, however, it appeared that the decomposition process in test landfills was more inhibited by intact plastic, paper bags, and other protective wrapping than by other wastes (10).

One partial solution in dealing with the disposal of degradable plastics (including both photo- and biodegradables) as well as non-plastic alternatives (i.e., paper, cardboard, etc.) is **shredding and composting**. One alternative to landfilling is the shredding of materials for later composting (11). Both photo- and biodegradable plastics, for example, could be shredded and composted. The shortcomings of this process, of course, result in the need for more land for composting purposes (space becoming more of a limiting factor) and the cost of shredding equipment. The Bill should specifically provide language calling for research into shredding and composting of degradable plastics and nonplastic alternatives, with a subsequent report to Congress on the research results.

This Bill was designed not only to cope with the nation's solid waste crisis, but also aid agricultural industries by studying and promoting non-food uses of agricultural commodities such as corn. One concern with the dual nature of this legislation is that if, in the future, the agricultural industry no longer needs subsidization or the promotion of non-food uses of commodities like corn, will the state agency purchase preferences be discontinued? It is important that this legislation not hinge on the availability of surplus agricultural commodities, which may fluctuate. The solid waste crisis will not disappear simply because of a change in the weather, or economic policies. The uses and purchases of degradable alternatives to non-degradable products should not hinge upon anything except the ability of our nation to properly dispose of its solid waste.

State and Local Legislation

The following is a brief overview of some of the state and local laws which are similar in form to S. 2298. Florida and Pennsylvania have enacted comprehensive solid waste management laws which regulate state agency procurements of materials which are not recycled or recyclable. Most of the other laws address the state or local agency purchases alone without addressing related issues. Iowa alone has enacted a law which specifically promotes state agency purchases of starch-based plastics.

Florida

S.B. 1192 (signed 6/24/88)

a. provides requirements with respect to procurement of products or materials with recycled content by governmental agencies.
b. specifies duties of state agencies, judicial branch, and State University system with respect to collection of recyclable materials and waste reduction.
c. directs Division of Purchasing to review and revise procurement procedures with respect to material with recycled content, or that may be recycled.
d. directs the Department of Transportation to review and revise bid procedures with respect to material with recycled content.
e. provides for a study of commercial product packaging and requiring a report.

Iowa

S.F. 2086 (signed 7/1/88)

a. promotes the procurement of starch-based plastics and soybean-based inks by the Department of General Services, the State Board of Regents, the Commission for the Blind, and the State Department of Transportation.

Massachusetts

Executive Order (signed 5/18/88)

a. requires state purchasing agent to expand purchases of recycled paper, aluminum and plastic.
b. requires state purchasing agent to cease buying disposable polystyrene products manufactured with

chlorofluorocarbons (CFCs).
c. requires state purchasing agent to cease buying all disposable polystyrene products not made out of recycled materials as of 6/1/89.

New York

Solid Waste Management Act of 1988, Chapter 70

a. promotes the procurement of recycled paper by state and local government entities.

Pennsylvania

S.B. 528 (signed 7/28/88)

a. requires Commonwealth agencies to procure recycled materials.

Rhode Island

R.I. Gen. Laws Section 42-11-14

a. requires state Department of Administration to give preference to recycled paper when procuring paper.
b. requires that information on recycled content be requested on all bids for products which could have recycled contents.

Buffalo, New York

Common Council Resolution
(Introduced by Messrs. Rutecki and Franczyk)

a. asks Mayor to ban city agency purchases of polystyrene foam products and to substitute non-disposable goods or paper products (preferably recycled paper products) for the polystyrene foam products.

As of this date, 17 states have enacted legislation requiring the use of degradable plastics in beverage containers: Alaska, California, Connecticut, Delaware, Florida, Iowa, Maine, Massachusetts, Michigan, Minnesota, New Jersey, New York, Oregon, Pennsylvania, Rhode Island, Vermont, and Wisconsin. Other states have introduced similar legislation and more probably will as public awareness of the problems of non-degradable plastic rings spreads across the country.

Some of the states have enacted relatively simple legislation without delving into the more technical aspects of plastics degradation. Other states, such as Alaska, California, Florida, Iowa, Michigan, and Rhode Island, have tried to define degradability more exactly or have addressed the plastic rings issue more precisely.

Photodegradation

Research Triangle Institute in Research Triangle, North Carolina, has been conducting studies on photodegradable Hi-Cone ECO plastic. Although Hi-Cone plastic is positively buoyant and floats in both fresh and salt water, it was feared that the plastic would become fouled with other nondegradable debris at sea, become buried in muck, or become covered with algae and thus not effectively photodegrade. The test results, however, were quite promising and the plastic performed quite well. Again, we are not advocating the disposal of degradable plastics at sea.

During the first week of at-sea exposure of the plastic to sunlight, 70 to 80 percent of the tensile strength of the plastic was lost. If an animal becomes entangled in a yoke during this time period, it very likely could break free from the considerably weakened plastic. After the initial loss of tensile strength, the weakening process apparently slows down considerably. On land, by the end of two months, the plastic had broken down completely (thus no tensile strength). At sea, it took about 12 weeks for the plastic to nearly break down (with most of the tensile strength lost). Algae did not prevent photodegradation.

Although the ITW Hi-Cone Company has a patent on the engineering design of the six-pack beverage ring and is now manufacturing the photodegradable plastic, other companies could also manufacture the degradable resin, including Union Carbide, Princeton Polymer Labs, Ampacet Corp., and others. ITW is also not committed only to photodegradability.

Another concern involves the controlled lifetime of degradable plastics. The plastic must be manufactured such that there is little chance of premature breakage. Controlled lifetime is not a difficult phenomenon to manage, and by chemically altering the amount of additives to the plastic, controlled lifetimes for plastics marketed in Maine, for example, can be made that are different from those in Arizona.

Biodegradation

The state-of-the-art regarding biodegradable plastics is not as far advanced as with photodegradables. Cornstarch plastic will break down on land but has not yet been demonstrated to do so at sea. Biodegradable beverage rings can be made with starch technology, but such material has not yet been shown to perform adequately either in the soil or in water. More research, testing, and evaluation are thus necessary as we have recommended in this Bill.

Crops such as corn, sugarcane, wheat, and barley can be fermented to produce high yields of lactic acid. Lactic acid polymers can be made into biodegradable plastic (12). More testing and evaluation are necessary, however.

Chitosan-derived plastic is another novel biodegradable product that has real potential (13), but no one has yet demonstrated that products other than clear plastic bags can be made from this material. Tough flexible films of chitosan-derived plastic, with a tensile strength of 20,000 psi, have been cast from dilute acetic or formic acid solutions. The films are virtually impervious to air and water (14). More research and evaluation are also needed here.

Examples of Degradable Plastics

The following are some examples of photo- and biodegradable plastics as well as some of their unique properties:

Photodegradables

Union Carbide manufactures a photodegradable plastic called ethylene-carbon monoxide. In Florida, the plastic may take only 2 weeks to reach the embrittlement stage, and it takes 2-4 weeks to reach the same stage in New Jersey. The plastic completely degrades in New Jersey within 5 months. Controlling the rate of degradation is possible by varying the amount of carbon monoxide that is incorporated into the plastic. The handling, extrusion, and fabrication of the plastic is similar to the process used to manufacture low-density polyethylene (LDPE) homopolymer, but a specially fitted high pressure reactor is needed. The plastic has the same physical characteristics as LDPE and is used notably for six-pack beverage rings. During storage the plastic must be protected from excessive ultraviolet radiation. When it decomposes, it is claimed that the by-products of the plastic are ultimately water and carbon dioxide which do not harm the environment.

E.I. du Pont de Nemours & Co. manufactures a photodegradable polyethylene called Elvax E/CO. Elvax degrades rapidly in sunlight or skylight (i.e., shade). In Fresno, California, in June, Elvax took only 4-5 days to degrade. In Boston, Massachusetts, in September, it took 30 days, and it took 60 days to degrade in Alaska during September and October. In Tennessee, Elvax took 10 days to degrade in March. The rate of degradation is capable of being controlled by varying the level of carbon monoxide incorporation. Elvax's physical characteristics are similar to LDPE. Du Pont has received FDA approval to use up to 30 percent of the copolymer in plastic used as an adhesive layer in indirect contact with food (21 C.F.R.175.105). FDA approval for up to 30 percent for use in direct food contact is pending. The plastic may be stored at 155 degrees fahrenheit (70 degrees celsius) for up to 10 months, and glass slows the degradation process by filtering out some light. There is no evidence to show that the dust particles that the plastic breaks down into are biodegradable.

The Ampacet Corporation manufactures a photodegradable plastic known as polygrade. Polygrade's rate of degradation depends upon season and location. Once the reactions have been activated by light, they will continue to occur with heat in the dark. Controlling the rate of degradation is also possible. Polygrade's additive is handled like pigment and can be produced in the same manner as high quality pigmented concentrates for film applications. It should be stored in opaque packaging and is used mostly for mulch films, garbage bags, and millinery bags.

Ecoplastics manufactures a photodegradable plastic called Ecolyte. Degradation of Ecolyte occurs under certain ultraviolet frequency exposures. Sun or skylight is needed to initiate the degradation. Artificial light will not trigger degradation, and glass can filter out the ultraviolet rays of natural light. The same equipment is used to manufacture Ecolyte as is used to manufacture other plastics, and Ecolyte has the same physical characteristics as regular plastic. The plastic breaks down into non-toxic ketone polymers which are reportedly substantially biodegradable by soil microorganisms. The polymers won't migrate so they won't contaminate food if used as packaging, and if they are ingested, they won't pass through the stomach or intestinal walls to infect the body.

Plastopil manufactures a photodegradable plastic called Plastigone. Plastigone can disappear from the environment within anywhere from 3 weeks to 12 months, and the rate of degradation is controllable. Once the degradation process begins, Plastigone will continue to degrade without sun or water. No special equipment is needed to manufacture Plastigone, which is used mainly as a mulch film. The plastic will retain its strength until just prior to degradation, and short sunlight exposure has no effect on the degradation process. Plastigone breaks down into small amounts of metals (nickel, cobalt, copper, and zinc). These metals reportedly have negligible effects on soil, but more research will be needed to determine whether these small amounts of metals are harmful to the environment or wildlife.

Biodegradables

Imperial Chemical Industries manufactures a biodegradable plastic called PHBV-POLY which is made from glucose or molasses. The rate of degradation for PHBV-POLY depends upon certain environmental factors. A thin plastic film in sewage may decompose within a matter of days, while a bottle in a landfill may take up to one year to degrade. Conventional plastics technology is used to manufacture the plastic, which has physical characteristics similar to traditional synthetic plastics. As long as the plastic is not stored in a high microbial activity environment it will not degrade in storage. The uses of PHBV-POLY include surgical and orthopedic devices, slow drug release systems, personal hygiene products, packaging, bottles, trays, and cards. When PHBV-POLY degrades, it is claimed that its by-products are water and carbon dioxide which are non-toxic and non-hazardous and enter the ecosystem safely.

Agritech Industries (ATI) is currently working with the United States Department of Agriculture and the University of Illinois on a starch-based biodegradable plastic. The plastic is made by blending polyethylene with compound agents and 15-80 percent cornstarch. The higher the percentage of cornstarch, the thicker the plastic will be. High amounts of cornstarch in the plastic also means that fungi, bacteria, and insects will consume the polymer as well as the cornstarch. Tests are currently being conducted to determine the extent to which the polymer is digested by insects. The rate of biodegradation will vary depending on a variety of factors, including the environment of disposal, the percentage of cornstarch to polymer, and the size and thickness of the plastic products. After a few months, a flexible film, with a relatively low percentage of cornstarch, can lose up to 50 percent or more of its mechanical properties. Shredded plastic will generally degrade more quickly than intact plastic products. The plastic may be stored indefinitely in a non-biologically active environment.

St. Lawrence Group Ltd. manufactures a "masterbatch" for a starch-based plastic called Ecostar. The masterbatch is made up of oxidant, plastic polymer, and starch, and it is turned into plastic products by companies which buy the masterbatch from St. Lawrence. The masterbatch may be used to make polyethylene, polypropylene, styrene, and polyvinyl chloride. It can be made into many plastic products including food packaging, carry bags, garbage bags, polypropylene binder twine, thermoformed polyethylene and styrene sheets, blow-molded bottles, composting bags, and vinyl wallpaper. The plastic is stable and degrades only in a biologically active environment.

When Ecostar plastic is disposed of in a biologically active environment, microorganisms will eat the starch molecules. When the oxidant in the polymers comes in contact with metals commonly found in soil, the oxidant will begin to eat away the plastic polymers. When they reach particulate size, these polymers will be attacked further by microorganisms. The St. Lawrence company claims that the ultimate by-products of the degradable plastic are carbon dioxide and water. The degradation rate of Ecostar depends on moisture, organisms, temperature, pH, metal salts, the percentage of polymer to active ingredients, the type of polymer, its surface area, and thickness. With 6 percent starch, degradation may take 3 to 6 years in a landfill. The more starch that is added, the less time the plastic will take to degrade. Additional equipment may be needed to manufacture Ecostar, and the masterbatch costs roughly 10 percent more to manufacture than non-degradable plastic.

CONCLUSION

While we perceive the use of degradable plastic as critical to alleviate the adverse impact of plastic on fish and wildlife, we recognize that degradability is no substitute for the proper disposal of plastic waste. The plastics problem can only be solved ultimately by a combination of efforts including degradability as a critical component in a comprehensive scheme for dealing with plastic waste. Passage of this legislation should begin to show the plastics' industry and the general public that Congress considers degradability a viable option in dealing with our massive plastic refuse problem. The language in the Bill -- along with our suggested changes and additions -- encourages and allows for the development of new degradability technologies, especially in the realm of biodegradability, which through research, testing and evaluation may ultimately provide even better solutions to our existing ones. We in the Entanglement Network Coalition strongly endorse this legislation and hope the Members of this Committee will do the same.

Mr. Chairman, thank you for the opportunity to testify here today. That concludes my testimony.

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REDUCING NAVY MARINE PLASTIC POLLUTION

A REPORT BY THE AD HOC ADVISORY COMMITTEE ON PLASTICS

TO THE ASSISTANT SECRETARY OF THE NAVY
FOR SHIPBUILDING AND LOGISTICS

June 28, 1988

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I. INTRODUCTION

Background

Over the last two decades, the United States and other nations have become increasingly aware of the impacts of human activity on the marine environment. In recent years, no environmental issue involving the oceans has engendered as much public attention and concern as marine plastics pollution. Plastic debris from ships is littering beaches, and killing and debilitating fish and wildlife because they are ingesting plastic, or because they are becoming entangled in plastic debris. While no one is purposefully causing these impacts, the effects are becoming more pronounced. In the United States and throughout much of the world, the use of plastics has grown exponentially. Plastic products are often more economical than non-plastic substitutes and present many attractive characteristics. Plastics enhance the shelf life and storage of products, provide ease in handling and use, and are durable and long lasting. As a consequence, the use of plastic products for food storage and packaging, and as a component of many everyday products, has increased significantly. The result is readily apparent in the increase in plastic use at home, in commercial use, and on board commercial and military ships.

Unfortunately, some of the characteristics that make the use of plastics so desirable create adverse environmental effects, particularly when disposed of in the marine environment. The proliferation of plastic products disposed of at sea is evident in the alarming increase in plastic beach litter worldwide. Plastic products are now found washing ashore in such remote places as Antarctica. Everyday solid wastes disposed of at sea now contain an increasing percentage of plastic products that do not degrade (ranging from plastic garbage bags, to styrofoam coffee cups, to plastic shrink wrap). These wastes are finding their way into the marine ecosystem and affecting (and oftentimes killing) marine life which have eaten or become entangled in six-pack rings, plastic strapping bands, or other plastic material.

Over the last several years, the international community has actively begun to address the problems of plastic pollution in the marine environment. In 1973, under the auspices of the International Maritime Organization in London, the United States and other maritime nations signed the International Convention for the Prevention of Pollution from Ships, known as MARPOL (which stands for Marine Pollution). MARPOL was developed to begin regulating pollution from ships resulting from operational and accidental discharges of oil, chemicals, sewage and garbage. Annex V of MARPOL focuses on the discharge of garbage from ships, including a ban on the disposal of plastics at sea. Annex V comes into effect for signatory nations one year from the date that it was signed by countries representing 50% of the world's

shipping tonnage (one year from December 30, 1987). MARPOL exempts military vessels from its provisions, including the prohibitions in Annex V, but requires that military vessels be operated in a manner consistent with MARPOL to the extent practicable. In implementing Annex V of MARPOL, the United States Congress, in Public Law 100-220 (Title II, the Marine Plastic Pollution Research and Control Act of 1987), required that military vessels comply with the provisions of Annex V in five years (including the ban on plastics disposal at sea) and develop a plan outlining how the Navy would approach compliance. Congress provided that this effort should not interfere with operations during wartime or during a national emergency. Congress also indicated that if the Navy believed it could not comply with the five year ban on plastics disposal, it would have three years to report back to Congress on the progress made and develop an alternative schedule.

Formation of the Committee

During preliminary discussions regarding the implementation of Annex V, the U.S. Navy expressed concern that it faced a potentially insurmountable challenge in complying with the five year marine plastics disposal provision. However, in September 1987 during Congressional hearings on this issue, Everett Pyatt, Assistant Secretary for Shipbuilding and Logistics, indicated that the Navy would make every effort to comply with the United States' commitment to Annex V of MARPOL. Shortly after that hearing, before the eventual enactment of the legislation by Congress, the Assistant Secretary asked The Keystone Center to convene and facilitate an advisory committee of representatives of environmental organizations and Congressional staff to help the Navy develop strategies to address the marine plastics pollution problem. The Keystone Center is a neutral, non-profit organization that mediates and facilitates multi-party dialogues on environmental issues.

On October 9, 1987, the Ad Hoc Advisory Committee on Plastics met for the first time. The Committee was chaired by Nancy Stehle, Deputy Director of Environment for the Navy representing the Assistant Secretary of the Navy for Shipbuilding and Logistics. Other Committee members included representatives from the American Cetacean Society; the Animal Protection Institute of America; the Oceanic Society; the Defenders of Wildlife; the Center for Environmental Education; the Texas Environmental Coalition; the National Audubon Society; the National Fish and Wildlife Foundation; the Monitor Consortium and Greenpeace U.S.A.; as well as Congressional staff from the Senate Commerce, Science and Transportation Committee; House Merchant Marine and Fisheries Committee; Senator Chafee's Office; and Representative Schneider's Office.

At that first meeting, the Committee Chair indicated that the Navy intended to make every effort to comply with the five year plastics provision in the legislation. She noted that the Assistant Secretary wanted the Ad Hoc Advisory Committee on Plastics to work with the Navy to develop recommendations that could be considered as part of the Service's overall strategy to address the plastics problem. The Chair asked Committee members to work with Navy personnel actively involved in Navy research and development, procurement and supply, operations, and shipboard environmental planning in developing its recommendations. Representatives from the David Taylor Research Center; Chief of Naval Operations; Commander in Chief, Atlantic Fleet; Naval Supply Systems Command; Naval Sea Systems Command; Navy Judge Advocate General's Corps International Law Division; Office of Navy Legislative Affairs; and the Office of the Assistant Secretary of the Navy for Shipbuilding and Logistics were introduced as resource people for the Committee. At the first meeting, the environmental representatives and Congressional staff requested that the Navy staff join with them on the Committee and work together to develop consensus recommendations that would eventually be submitted to the Assistant Secretary. The group felt that formally expanding the Committee to include all perspectives would enhance mutual understanding and lead to recommendations that were environmentally sound and based on the realities of Navy operations.

Since October 9, 1987, the Ad Hoc Advisory Committee on Plastics has met seven times in full group meetings. Committee members have also participated in numerous subcommittee meetings as well as three on-site visits. During the early stages of its work, the Committee focused on establishing a common framework for understanding the nature of the problem, the special challenges faced by the Navy, and the nature of existing information and programs currently being used by the Navy to address the plastics problem. During this early phase, the Committee reviewed data regarding the types and quantity of plastics used on board ship; the effects of ship size and type of operations on the generation of plastic waste and on the ability to store and dispose of plastics; as well as existing and planned technological innovations that might contribute to resolving the problem. The Committee visited the David Taylor Research Center in Annapolis, Maryland to learn about technology options; spent two days with the Commander in Chief of the Atlantic Fleet and his staff; and spent time on board several ships at the Norfolk Naval Station in Virginia to learn more about Navy supply systems, operations, and planning processes. Some Committee members also spent two days on board an aircraft carrier at sea working with Navy staff to better understand shipboard life and the nature of the plastics problem on board a large ship with five thousand crew. During the carrier visit Committee members

had an opportunity to meet with Navy personnel who would be directly affected by the Committee's recommendations and to exchange thoughts about possible solutions.

After a substantial commitment of time and energy devoted to understanding the nature and extent of the problem for the Navy, the Committee concluded that no single easy solution could eliminate the problem. At that point, the group began to realize that addressing the marine plastic pollution problem would require a combination of approaches, each contributing to the reduction and elimination of the disposal of plastics at sea.

The Report

The attached report represents nine months of effort and commitment by the Ad Hoc Advisory Committee on Plastics. It is a consensus document by the Committee and is separated into four sections: supply, technology, operations, and education. In developing recommendations, the Committee attempted to take the Navy's primary mission into account, as well as the realities of shipboard life, and the challenge of affecting change in a large organization. The Committee also tried to take into account unique opportunities presented by the realities of the Navy including the Navy's historic pride in leadership as a Service; the level of pride found on each ship; the Service's substantial research and development capability; the "can do" attitude found throughout the Navy; unique aspects of the supply and operations systems; and the environmental sensitivity found on shipboard visits.

The supply recommendations, discussed first in the report, are considered to be of the highest priority by the Committee. The reduction in the amount of plastics coming on board a ship will greatly reduce the need for expensive technologies intended to facilitate storage and disposal. The Committee believes that the reduction of plastics in the Navy supply system is the most direct and cost effective solution to the marine plastics problem and can significantly reduce the discharge of plastic at sea. The Committee worked very closely with the Naval Supply Systems Command and communicated with the Defense Logistics Agency and the General Services Administration in developing this section of the report. The recommendations included in this section attempt to reflect the realities of the Navy supply system and on board use of materials. They range from identifying high volume food items for which non-plastic packaging is now available, to conducting waste stream surveys on ships at sea, to reviewing existing supply specifications with an eye toward procuring the same items in non-plastic packaging. The remaining sections of the report are not prioritized.

The second set of recommendations presented in the report addresses technology options. The Committee worked closely with representatives from the David Taylor Research Center, Naval Sea Systems Command, Chief of Naval Operations, and Atlantic Fleet Command to draw upon emerging technologies being developed by the Navy or considered elsewhere. The Committee also worked with the Navy to identify potential new areas of research that might provide technological solutions to the plastic marine pollution problem. The trash compactor and the plastic waste processor discussed in this section of the report present very viable alternatives that could contribute to Navy compliance with the plastics disposal provision in the legislation. While the costs associated with research and development, production and installation might seem high, the extent of the problem and the relative contribution to solving the problem appear to justify the expenditure and appear consistent with other Navy innovations. The recommendations in this section encourage the development of technologies to handle and dispose of plastics and call for the development of new materials with the properties of plastic that will degrade rapidly in the marine environment.

The third section of the report focuses on operations. This section focuses on opportunities for change in shipboard procedures that could be made in the short term to assist in: reducing the amount of plastic used, enhancing storage possibilities while at sea; and developing disposal restrictions. Again, the Committee worked closely with Navy staff and drew upon the group's shipboard experience to develop recommendations that could be implemented in a cost efficient manner. The recommendations in this section include suggestions to off-load unnecessary plastic wrapping and trash before leaving port, separate and store plastic trash, and initiate conservation and recycling policies on a fleetwide basis.

The fourth and final section of this report focuses on education. If the Navy is to implement an ongoing strategy to manage, reduce, and eliminate plastics at sea, it will need to inform its personnel about the nature of the problem; communicate the Navy's commitment to solving the problem; encourage new ideas; and generate support for shipboard and service-wide activities. The recommendations in this section call for disseminating information about the plastic debris problem and distributing the Navy's plan to all Navy personnel, developing educational materials, for naval supply centers and procurement offices, utilizing special awards for ships, and developing a shipboard education package. The Committee is pleased to report that many of the education recommendations already have begun to be implemented as part of the Ship Waste Plastics Control Demonstration Project by the David Taylor Research Center and Atlantic Fleet Command. The Committee regards the steps already taken as a positive sign of Navy commitment to solving the marine plastics pollution problem.

In each section of the report, the Committee summarizes the recommendations generated in that section followed by a narrative explaining the justification for each recommendation (i.e., the problem it will address). This is followed by a brief discussion of what is currently being done by the Navy regarding that particular recommendation as well as what needs to be done in the future. The Committee then outlines a time frame for completion of the proposed recommendation, identifies responsibility for the next steps within the Navy, estimates the costs for the recommendation (in 1988 dollars), and ranks the relative priority of the recommendation within that section. The Committee wishes to underline that the cost estimates are just that, estimates. The Committee attempted to draw upon the expertise of Navy staff as well as prior examples of Navy work to develop the cost estimates. In some areas, this neatly fell into a fairly predictable dollar category. In others, such as the supply and operations sections, the costs include human resource costs which are difficult to measure. Where hard dollar estimates were not readily available, the Committee depended exclusively on estimating the cost as high, medium or low. This represents a ranking of recommendations relative to each other within a section of the report to communicate the perceived relative expense of each recommendation. Finally, it should be noted that each recommendation is prioritized (i.e., high, medium, low) relative to the other recommendations within that section of the report. The recommendations are presented in the order of perceived importance within each section.

Comment

The formation of the Ad Hoc Advisory Committee on Plastics by the Assistant Secretary of the Navy was a significant step in facilitating an aggressive approach to the marine plastics pollution problem. The formation of this Committee also promoted a more collaborative and open relationship between the Navy, environmental organizations, and Congressional staff involved in environmental policy issues. The early stages of this Committee's work were particularly challenging. All participants approached the process with substantial uncertainty and skepticism. Parties who were accustomed to dealing with each other with a large measure of distrust were suddenly asked to work together to achieve a common goal. Added to that was a sense of being overwhelmed by the extent of the problem and the nature of the task at hand. As the consensus building process developed, our communication and effectiveness increased and we became more open. Over time, the spirit of cooperation became outstanding. The Committee has committed long hours to this effort because the members believe the problem is significant and because we are anxious to help the Navy take a leadership role in reducing and eventually eliminating marine plastic pollution. It is the Committee's hope that the other navies of the world will take note and learn from the U.S. experience, and that other U.S.

agencies (such as the Defense Logistics Agency and General Services Administration) will review and use some of the recommendations that follow.

It would be inappropriate to convey this report without acknowledging the critical role the Committee Chair played throughout this process. Nancy Stehle, as the representative of the Assistant Secretary for Shipbuilding and Logistics to the Committee, set the example and established the tone we all needed for frankness and openness. She focused our attention on helping the Navy solve the problem and made available to us the resources we needed to pursue this important task.

The work of the Committee provides a positive step toward eliminating the problem of marine plastic pollution. We believe, if the recommendations in this report are implemented, they will result in an aggressive Navy program to solve the marine plastic pollution problem. The establishment of the Committee was a step in the right direction. It demonstrated that the Navy was serious about addressing this environmental issue. Throughout this process, we found a great deal of environmental sensitivity among Navy staff and a commitment to help solve the marine plastics pollution problem. The Committee process gave those of us outside the Navy an opportunity to demonstrate that we can not only help identify critical environmental problems but can help develop appropriate strategies to address them. Finally, the formation and work of this Committee was a step in the right direction because it opened up a new line of communication between the Navy and those of us concerned with environmental protection. We hope that all sides can build upon and expand the dialogue in the future.

II. SUPPLY

The Navy supply system is the first point at which the Navy can reduce or eliminate its use of plastic and is considered the highest priority for action by the Ad Hoc Advisory Committee on Plastics. The elimination or reduction of plastic packaging in the supply system can have a significant impact on other points in the waste stream. If less plastic packaging is purchased, less plastic will need to be handled and stored on ships for off-loading later. Less plastic which has to be stored means less wear and tear on shipboard equipment such as compactors, processors or thermal destruction devices.

The intent of this section of the Committee report is to help the Navy identify plastic in the supply system, evaluate the use of plastic on board ship and develop strategies to help prevent its purchase and deployment to Navy vessels where possible.

One need only look at the shelves of the local grocery store to see how pervasive plastic packaging is in our society. Special needs of the Navy, such as long periods of time spent away from port, the rolling movements of ships at sea, high humidity on board ships, and the corrosive nature of salt air and spray make plastics even more attractive for use on ships than in ordinary household environments.

Most of the recommendations in this section deal with plastic food packaging. Although quantitative studies have not yet been completed, available data indicate that packaging of these food items constitute the largest part of the plastics on board Navy ships. These items are used on board all vessels in the Navy and make up a large part of stores which must be replenished periodically. In addition, shipboard storage of plastic which has contained food may pose a sanitation problem. For these reasons, the supply system, in general, and plastic food packaging, in particular, were considered a high priority area by the Committee. The Committee based its determination of priorities for the supply recommendations on the contribution to reduction in plastic use, time required for implementation, and financial costs involved.

A. SUMMARY OF SUPPLY RECOMMENDATIONS

1. Identify high volume food items for which non-plastic packaging is now available.

2. Conduct waste stream surveys on ships at sea.

3. Select and order non-plastic packaging alternatives for test runs on demonstration ships based on results of waste stream surveys.

4. Review all existing supply specifications for possible procurement of items in non-plastic packaging. Change to non-plastic packaging where possible.

5. Identify and implement use of alternatives to plastic repackaging and over-pack materials at Naval Supply Centers throughout the United States and the Naval Supply Depots overseas.

6. Work with the General Services Administration (GSA) and the Defense Logistics Agency (DLA) to gain their cooperation in identifying non-plastic packaging for items they order for the Navy. Secure ongoing support and assistance from the Office of the Secretary of Defense (OSD) and other military services.

7. Review ships' stores to identify plastic packaging which can be eliminated.

8. Establish within the Naval Supply Systems Command (NAVSUP) a Plastic Program Manager Office to plan, manage and coordinate NAVSUP's efforts to reduce plastics going on board ships.

9. Change supply/specification policy to include steps to investigate availability of non-plastic or reusable packaging.

10. Review Department of Defense (DOD) research on alternate non-plastic packaging and other DOD projects for applicability to the plastic disposal problem.

11. Review military, government and commercial data bases for research projects having possible impact on the plastic disposal problem. Particular attention should be paid to those projects dealing with non-plastic packaging. Investigate promising projects.

12. Poll scientific organizations, industry groups, trade associations and individuals to find projects contemplated or underway which affect the plastic disposal problem. Test promising proposals.

B. NARRATIVE DISCUSSION OF RECOMMENDATIONS

1. Identify high volume food items for which non-plastic packaging is now available.

Justification: There are food items on the Navy's supply list for which non-plastic packaging may be available. The switch to alternative packaging for these items may be made relatively quickly, providing the Navy with a definitive early success in its efforts to reduce plastic waste.

What has been done: Lists of all food items ordered by the Navy have been reviewed. Approximately 30 high-volume items with plastic packaging have been selected for evaluation. Letters have been written to the Defense Logistics Agency and General Services Administration inquiring whether non-plastic packaging is available for these items. The U.S. Army Research Development and Engineering Center in Natick, Massachusetts has been asked to develop specifications for non-plastic alternative packaging (see Recommendation 10). These 30 items were used as examples of products needing alternative non-plastic packaging.

What needs to be done: Other food items will be identified to DLA for possible change in packaging. For those items that have already been identified, it must be determined whether non-plastic packaging is suitable for Navy vessels. Changes in procurement will be phased in as appropriate.

Time frame for completion: 6-12 months.

Responsibility: Navy Fleet Commands and Naval Supply Systems Command.

Cost Estimate: Low administrative cost (could be part of the Plastic Program Manager Office's responsibility discussed in Recommendation #8). Product cost may be higher, however, for non-plastic, non-commercial packaging.

Priority: High.

2. Conduct waste stream surveys on ships at sea.

In these studies of shipboard trash, the test vessel keeps all trash on board ship for a specified period of time. The plastic waste is then analyzed to determine the type, weight and volume of plastic.

Justification: Waste stream surveys will identify types of plastic waste that contribute most to the weight or volume of plastics on ships. These "worst offenders" can be targeted for elimination or reduction sooner than other items which might not contribute as much to the plastic disposal problem.

What has been done: Statements of work have been provided to the David Taylor Research Center by the Atlantic Fleet, Naval Supply Systems Command, and Naval Sea Systems Command.

What needs to be done: Proceed as quickly as possible with the studies.

Time frame for completion: Baseline studies - 1988; continuing studies - 1989.

Responsibility: Chief of Naval Operations, Fleet Commands, and David Taylor Research Center.

Cost Estimate: Low (approximately $350,000 for Recommendations 2 and 3).

Priority: High.

3. Select and order non-plastic packaging alternatives for test runs on demonstration ships based on results of waste stream surveys.

Changes in supply and operational procedures will be tested on demonstration ships to ascertain their impact.

Justification: Results of the waste stream studies will identify high volume items whose change to non-plastic packaging will theoretically lessen the amount of plastic to be disposed, but verification of the results on board actual ships is necessary. These trial runs will allow evaluation of a significant dollar investment in hardware, including development and deployment of shipboard compactors, pulpers and plastic waste processors, and will provide a blueprint for the success of the entire plastics reduction program.

What has been done: Chief of Naval Operations has tasked (i.e., requested) fleets to plan demonstration projects. David Taylor Research Center has been tasked as project manager.

What needs to be done: Demonstration projects should be completed and evaluated.

Time frame for completion: Tasking calls for preliminary reports on the first two ships by 30 June, 1988. Final report of demonstration projects is due 30 March, 1989.

Responsibility: Chief of Naval Operations.

Cost: Low ($350,000 for this program and waste stream studies in Recommendation 2).

Priority: High.

4. Review all existing supply specifications for possible procurement of items in non-plastic packaging. Change to non-plastic packaging where possible.

Specifications will be chosen for review based on results of waste stream studies. Where alternate non-plastic packaging is now available, it should be ordered. Suppliers should be asked to determine whether they would supply products in non-plastic packaging if requested by the Navy. Where specifications require plastic packaging, it should be determined if plastic packaging is functionally necessary. If it is determined that non-plastic packaging would suffice and the supplier will offer it, the alternate packaging should be ordered.

Justification: There may be opportunities to reduce the amount of plastic taken on board ships by simply reviewing existing procurement specifications or asking vendors for non-plastic packaging.

What has been done: Project description and budget for contracted work have been developed.

What needs to be done: Conduct complete analysis of packaging specifications. Change specifications where appropriate. To insure the greatest benefit of review, specifications for high volume items should be targeted, (e.g., food items first, high volume items from waste stream study second, those packing specifications that have application to the greatest number of end items, such as those which have similar packaging needs, third).

Time frame for completion: Analysis - 12 months for food items, 24 months for other high volume items; change in procurement - 2-3 years from identification.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Medium ($200,000 a year for five years).

Priority: High.

5. Identify and implement use of alternatives to plastic repackaging and over-pack materials at Naval Supply Centers throughout the United States and the Naval Supply Depots overseas.

Justification: Personnel will be responsible for removing plastic from ships before deploying and repackaging items to eliminate plastic. Example: under current procedures, supply centers and depots repackage material in plastic shrink wrap, stretch wrap, bubble wrap, and micro foam. This procedure should be changed where possible. Changing the procedure may require new equipment and personnel.

What has been done: A recommendation to add packing/packaging personnel at Naval Supply Centers and Naval Supply Depots has been approved by the Assistant Secretary of the Navy for Shipbuilding and Logistics.

What needs to be done: The Naval Supply Systems Command should identify alternative pre-packaging materials and methods and implement new procedures.

Time frame for completion: 1989.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Medium (approximately $1.4 million annually).

Priority: High.

6. Work with the General Services Administration (GSA) and the Defense Logistics Agency (DLA) to gain their cooperation in identifying non-plastic packaging for items they order for the Navy. Secure ongoing support and assistance from the Office of the Secretary of Defense (OSD) and other military services.

Justification: The Naval Supply Systems Command is in control of the purchase of only 20-25% of the items taken on board Navy ships. Other government procurement organizations control the remainder. The Navy should attempt to educate these other organizations about the problem of marine plastic pollution and obtain their cooperation in solving it. The Committee wishes to point out that a certain percentage of marine plastic pollution originates from land-based sources. In addition, the disposal of plastic is increasingly being recognized as a serious problem for land-based, as well as marine, operations.

By helping the Navy reduce plastic packaging for items purchased, other government procurement organizations will help solve the problem of plastic in the marine environment.

What has been done: Points of contact at GSA and DLA have been established. The Armed Forces Product Evaluation Committee has also been advised of the problem.

What needs to be done: The Navy should identify offices in other military services, such as the DOD Food Planning Board and other DOD groups, and begin discussions with them.

Time frame for completion: 1988.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Low (could be part of the Plastic Program Manager Office's responsibility outlined in Recommendation #8).

Priority: High.

7. Review ships' stores to identify plastic packaging which can be eliminated.

Justification. Ships' stores often contain items which are unnecessarily packaged in plastic.

What has been done: A contract for 11 million plastic shopping bags destined for ships' stores has been cancelled. Six-pack rings and plastic over-wrap for soft drink containers have been targeted for elimination. Letters have been written to suppliers announcing the change. Other items are being reviewed for possible change.

What needs to be done: Review should continue.

Time frame for completion: Ongoing.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Unknown (may result in increased cost to individual sailors for ship stores items).
Priority: High.

8. **Establish within the Naval Supply Systems Command (NAVSUP) a Plastic Program Manager Office to plan, manage and coordinate NAVSUP's efforts to reduce plastics going on board ships.**

Justification: This Office will be responsible for executing the Naval Supply Systems Command plan of action and establishing Navy policy through coordination with NAVSUP, field activities, other Navy activities, military services and federal agencies.

What has been done: A recommendation to establish a Plastic Program Manager Office has been provided to the Assistant Secretary of the Navy for Shipbuilding and Logistics.

What needs to be done: Naval Supply Systems Command must obtain funding and establish the program office.

Time frame for completion: 1989.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Medium (approximately $200,000 annually).

Priority: High.

9. **Change supply/specification policy to include steps to investigate availability of non-plastic or reusable packaging.**

Justification: The search for non-plastic or reusable packaging should be an on-going process in the supply system.

What has been done: No action.

What needs to be done: Naval Supply Systems Command should initiate a proposed change in the procurement process for evaluating the availability of the non-plastic or reusable plastic packaging in all procurement activities.

Time frame for completion: 6 months.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Unknown (cost of product may be higher due to use of non-commercial packaging).

Priority: High.

10. **Review Department of Defense (DOD) research on alternate non-plastic packaging and other DOD projects for applicability to the plastic disposal problem.**

Justification: Some research is already underway at U.S. Army Research Development and Engineering Center, in Natick, Massachusetts (Natick Laboratories), which will help reduce the amount of plastics on board ships. Possibilities include projects which have a direct impact on Navy efforts, such as development of a non-plastic food container. Others, such as research into ambient temperature washing capability (washing dishes with room temperature water), will have an indirect impact on the disposal of plastic. If it is successfully implemented, plastic utensils will not be necessary when a ship loses steam power.

What has been done: Natick Laboratories have been requested to develop non-plastic food packaging that achieves the desirable characteristics of plastic packaging such as storage life and sanitation. Research on ambient temperature washing capability has been completed.

What needs to be done: Specifications should be developed for non-plastic packaging for circulation to vendors as an example of possible future packaging requirements.

Time frame for completion: 1989 - 1992.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Medium ($100,000 - $500,000 per year).

Priority: High.

11. **Review military, government, and commercial data bases for research projects having possible impact on the plastic disposal problem. Particular attention should be paid to those projects dealing with non-plastic packaging. Investigate promising projects.**

Possibilities include Defense Logistics Studies, Information Exchange Search, Defense Technical Information Center, and National Technical Information Service (Commerce Department).

Justification: The Navy should take advantage of work already completed, or in progress, which would have an effect on the plastics disposal problem.

What has been done: The Navy has received initial products from Defense Logistics Studies Information Exchange Search and Defense Technical Information Center.

What needs to be done: The National Technical Information Service should be contacted. Analysis of products already received should be done.

Time frame for completion: Searches - 1988; investigation of projects - 1989.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Low.

Priority: Low.

12. Poll scientific organizations, industry groups, trade associations and individuals to find projects contemplated or underway which affect the plastic disposal problem. Test promising proposals.

Possibilities include placing advertisements in Commerce Business Daily, talking to industry groups such as the National Paper Institute, and discussions with scientific organizations such as the National Research Council/ National Science Foundation.

Justification: The Navy should encourage other organizations to get involved in research which pertains to solutions to the plastic pollution problem and should take advantage of research which is already underway.

What has been done: Commerce Business Daily Request for Information has been published.

What needs to be done: Other organizations, such as those mentioned above, should be contacted and analysis done on information received.

Time frame for completion: Review - 1988; test - 1989-1990.

Responsibility: Contacting Commerce Business Daily, industry groups - Naval Supply Systems Command; liaison with National Research Council - Assistant Secretary of the Navy for Shipbuilding and Logistics.

Cost Estimate: Low.

Priority: Low.

III. TECHNOLOGY

Although some solutions to the Navy's plastic waste problem can be implemented immediately and are fiscally inexpensive, others will require highly technical and somewhat expensive hardware. Some of this equipment is now undergoing field testing, with fleetwide installation of the equipment imminent. Other equipment will require design, prototype construction, testing, and evaluation before installation and use can occur. Although the estimated cost for all of the hardware is significant, the Committee believes that the overall benefits will far outweigh the costs. Benefits derived from the use of this equipment and these technologies will not only help the Navy deal with its plastics problems, but will assist the Navy in addressing the overall waste management challenge presented by other solid wastes such as paper, cardboard, metal, and glass. Some of the recommended technologies described below, not targeted exclusively at plastics, will provide more space, save more time, and utilize less labor, and will thereby contribute to solving the marine plastic pollution problem. Although some technological solutions will require years of development, the Committee recommends that the Navy consider all options for dealing with the management of plastic waste.

The Advisory Committee based its determination of priorities in this section of the report on the following criteria: feasibility, proven nature of the technology, level of significance in reducing the plastics waste stream, level of significance in reducing the non-plastics waste stream, short-term versus long-term nature of the solution, potential for greatest impact, need for a technology, and cost.

Please note that food waste disposers/grinders were not considered as part of this analysis because their use does not contribute to reduction or elimination of plastic disposal, or other non-food-related wastes.

A. SUMMARY OF TECHNOLOGICAL RECOMMENDATIONS

1. Trash Compactor
2. Plastic Waste Processor
3. Enhanced Degradable Packaging Materials
4. Solid Waste Pulper
5. Thermal Destruction Device
6. Dedicated Garbage Barge

B. NARRATIVE DISCUSSION OF RECOMMENDATIONS

1. Trash Compactor

Justification: Use of a trash compactor will greatly facilitate storage of plastic and other garbage (e.g., paper, cardboard, metal, and glass) on board ship. It will provide tremendous space-savings, with easier handling and off-loading of compacted trash. Installation and use of the vertical trash compactor fleetwide would implement a feasible, proven technology. Its use is applicable to all ships in the Navy, regardless of size. The compactor is fully automated and is designed to take many types of trash, including plastics.

If, in the future, trash is separated -- glass, metal, paper, and cardboard -- recycling efforts, if developed, could be expedited. In addition, compaction of non-plastic waste will result in greater available space for dealing with plastic waste. It will also facilitate easier overboard disposal of these wastes due to their compact characteristics, and it will enable better storage of wastes which cannot be dumped overboard while ships are in no dumping areas.

The trash compactor is designed to be a breakdown model and, thus, can be taken piecemeal onto each ship, eliminating the need to cut and reweld the hull to bring the compactor on board. Since ships are normally in a shipyard for three-month periods, installation can easily be completed during that time. Any industrial shipyard can accomplish the fitting.

What has been done: A prototype has been built and tested at the David Taylor Research Center in Annapolis, Maryland. The prototype is now being tested on a destroyer class vessel.

What needs to be done: The prototype, already installed on the USS O'Bannon (a destroyer), is being field/sea tested for six months. This will be followed by six months of technical evaluation, plus an additional six months of operational evaluation. Procurement will require an additional year resulting in initial installation during the fall of 1990 (these are best case time estimates for this and the following analyses; times could likely be shortened somewhat, but probably at far greater costs). Destroyers will be outfitted first, with installation dependent on ship availability.

Time frame: Five years to completely outfit all Naval vessels once the unit is mass produced.

Responsibility: Naval Sea Systems Command (NAVSEA).

Cost Estimate:

Research and Development:	$ 1 million to complete.
Acquisition:	$62 million
Installation:	$68 million

Priority: High

2. Plastic Waste Processor

Justification: The Plastic Waste Processor (PWP) will deal specifically with all plastic waste. It will function much like a trash compactor containing a built-in heating/melting unit. Compressed plastic will be melted, then cooled into small, solid, sterile plastic bricks for later land-based disposal or possible recycling. The sterile bricks of plastic will result in easier storage, handling, and off-loading. There is a need for this machine, especially on board large combatants, tenders, and carriers because of the large volume of waste generated and limited storage space. Use of the PWP will result in tremendous volume reduction of plastic -- a major problem with such items as bubble wrap. The processor will also sterilize plastic food wrap, eliminating a major health hazard and over-riding health concern.

What has been done: Engineering and design of a prototype have begun.

What needs to be done: After the design of a processor that will accept all plastic, a prototype will be built with testing, evaluation, production, and installation. The PWP should be fully automated.

Time frame:

Research and Development: 3-4 years. Five additional years to completely outfit all large surface ships once the unit is mass produced.

Responsibility: Naval Sea Systems Command (NAVSEA)

Cost Estimate:

Research and Development	$11 million
Acquisition	$50 million
Installation	$46 million

Priority: High

3. Enhanced Degradable Packaging Materials

Justification: Since the physical qualities of plastics are extremely desirable -- durable, waterproof, lightweight, bacteria-resistant, etc. -- if non-plastic alternatives can be developed which possess similar qualities and are not persistent, but will allow overboard disposal, then part of the plastics problem will be solved.

Development of enhanced degradable packaging materials (EDPM) could help solve much of the Navy's plastic waste stream problem if the Navy can convince industry to adopt alternative packaging practices. Work in this area could actually enhance the Navy's ability to leverage industry to develop and use EDPM's.

What has been done: The Navy recently signed a contract with Research Triangle Institute (RTI), North Carolina, to continue work on developing degradable plastics, and to test commercially available products which may be of use to the Navy (e.g., 100% biodegradable cellulose cellophane, cardboards).

What needs to be done: RTI should continue testing existing commercially available products, and should attempt to develop a degradable plastic-like product which may be used on board ships as a substitute for conventional plastics.

Time frame:

Research and Development phase: 2-7 years (because of the many unknowns with this type of exploratory development program).

Responsibility: Office of Naval Technology.

Cost Estimate: $2 million over 2-7 years.

Priority: High

4. Solid Waste Pulper

Justification: The solid waste pulper (SWP) will deal primarily with the paper waste stream, acting as a cost and labor-saving device for eliminating paper. Incidental to its operation, the SWP will separate plastic from paper, allowing for removal of plastic from the pulper (e.g., plastic liners in paper bags, accidental plastic disposal). Paper waste will be directly discharged into the ocean eliminating the need to hand-carry some paper to the compactor and/or fantail. The paper plugs generated by the pulper will be small, easily biodegradable, wet, and negatively or neutrally buoyant. In this form, the waste is expected to deteriorate quickly in the marine environment.

The SWP will deal specifically with the paper waste stream, acting as a tremendous labor-saving device. Environmental deterioration/degradation of the paper will be greatly enhanced by size reduction and the wetting of paper waste. Crew involvement in waste elimination should be considerably lessened.

What has been done: A development contract has been awarded to Somat Corporation, Pomeroy, Pennsylvania. A demonstration model has been developed.

What needs to be done: Development should be carried out in four phases:

1. Field/sea testing and evaluation of the pulper.
2. Construction of a preproduction model.
3. Construction of a production model to be installed, tested, evaluated, and readied for commercial production.
4. Commercial manufacture and installation on all larger surface ships.

Time frame:
Research and Development: 3-4 years.
Production and installation - onto larger surface ships: 5-7 years. (Production and installation are budget driven. Research and development can be accelerated, installation cannot.)

Responsibility: Naval Sea Systems Command (NAVSEA).

Cost Estimate:

Research and Development	$ 4 million
Production/acquisition	$20 million
Installation	$48 million

Priority: Medium

5. Thermal Destruction Device

Justification: The thermal destruction device (TDD), as it presently exists, is a large, but trailerable, plasma-arc heating unit which produces temperatures through electrical arc generation greater than 5,000 degrees Fahrenheit. Large quantities of electricity are needed to create temperatures high enough to vaporize waste products. Existing equipment is now being used for soil pyrolysis decontamination.

Newly emerging thermal destruction devices have a potential to solve part of the Navy's plastic waste problem particularly on larger ships with crews of more than 600 people. Some emerging TDD's hold promise in providing safe destruction of trash; however, none have been fully tested to demonstrate environmental acceptability, particularly for burning plastic trash. The TDD would be particularly useful at foreign ports where countries are not willing to accept Navy waste. Use of the TDD would remove Navy dependence on inshore waste facilities, at least on larger ships in which it would be installed. Any TDD technology must meet all of the requirements of the Ocean Dumping Act. All TDD systems should meet Clean Air Act standards for similar land based systems to maintain high environmental and human health standards.

We support the Navy's rejection of commercial marine incinerators because of the environmental, safety, and human health hazards they pose.

What has been done: An available technical assessment has been completed by the Navy. The Navy continues to identify pyrolysis and plasmolysis technologies which may be potentially scaled down.

What needs to be done: Industry should be contacted to determine possible interest in the project. Analyses of engineering and feasibility should to be conducted. A scaled down model should be designed and built. This would lead to the design and production of a full-scale model. The Navy needs to scale down such a machine; although, scaling them down will reduce the throughput capacity (pounds per hour of burnables). Design and construction of a TDD is a highly technical issue, requiring answers to a number of technical issues including: materials issues, heat expansion, corrosion, weight, available energy, and exhaust emissions.

Time frame:

Research and Development: 5-7 years

Installation: 5-7 additional years to completely outfit all larger surface ships once unit is mass produced.

Responsibility: Naval Sea Systems Command (NAVSEA)

Cost Estimate:

Research and Development:	$10 million
Acquisition:	Cannot estimate
Installation:	Cannot estimate

Priority: Medium

6. **Dedicated Garbage Barge**

Justification: The dedicated garbage barge would serve as a ship-towed barge specifically designed to haul plastic and other wastes in special use areas (e.g., the Antarctic, near-shore operations).

What has been done: No action. Creation of a fleet of dedicated garbage ships is feasible. However, there may be problems in obtaining acceptance of waste by these ships in foreign countries. Economic incentives -- separated waste (metal, glass, paper) for recycling -- may increase the likelihood of foreign acceptance of Navy waste.

What needs to be done: Evaluate the cost of developing a fleet. Identify where there may be a need for this service. Explore land-based disposal options in one fleet to determine the feasibility. Compare costs of this option with other alternatives in the long term.

Time frame: Long term.

Responsibility: Fleet Command.

Cost Estimate: $10's of millions.

Priority: Low

IV. OPERATIONS

Operational responses to the plastic problem on board Navy ships focus primarily on altering routine practices for dealing with plastic trash to facilitate: (1) reductions in the amount of plastic used and brought on board the ships; and (2) separation and stowage of plastic for proper offloading.

In most cases, operational responses do not require the development of a new technology or changes in procurement practices. For that reason, many of the operations recommendations can be instituted immediately and will result in an immediate reduction in the amount of plastic discharged at sea. The cost estimates associated with each recommendation are approximate because many of the recommended actions regarding operations primarily involve human resource costs. Although these costs may be quantified in hours of labor expended, other human resource costs (e.g., morale) are virtually impossible to quantify.

Recommendations in this section are prioritized based on the contribution each recommended action will have on reducing the amount of plastic brought on board ship and the extent to which each recommended action will facilitate elimination of the need for plastic discharge. Generally, success in achieving the first three recommendations in this section will determine the degree to which all other recommendations in the Operations section of the report will need to be pursued.

A. SUMMARY OF OPERATIONS RECOMMENDATIONS

1. Prior to leaving port, the maximum amount of packing materials and other plastic trash should be offloaded from ships.
2. Separate plastic trash.
3. Store plastic trash for offloading.
4. Consider storage of used plastic wrapping from foods in closed container in freezer.
5. Locate plastic waste receptacle on fantail of ship or other trash discharge location.
6. Until full compliance is achieved, determine "no plastic discharge zones" for each class of ship.
7. Initiate conservation and reuse/recycling policies on a shipwide basis, especially target shipping and receiving areas.

8. Eliminate plastic liner in trash can.

9. All Commanding Officers should require that, wherever possible, plastic items (e.g., coffee cups, coffee stirrers) be replaced with non-plastic items and that disposable items used on board ship be replaced with reusable items (e.g., disposable aprons, gloves, dry cleaning bags).

10. Designate Environmental Officer (on collateral duty) for each ship to integrate responsibility for all environmental systems, including collection, holding and transfer (sewage) system, hazardous materials/hazardous waste systems and trash disposal.

11. Determine capacity for storage of plastic trash for each class of ship, beginning with demonstration ship.

12. Evaluate the feasibility of sanitizing plastic trash and subsequent storage on board ship.

13. Until full compliance is achieved and the Act takes effect for Navy vessels, each vessel should maintain a ship's log for recording all discharges of trash. The Navy should develop a system for using this data to measure progress in achieving compliance with the legislation.

14. Evaluate storeroom designs and operating procedures to facilitate storage of plastic trash.

15. Evaluate use of supply ship for offloading of certain plastic trash, pallets and reusable items or materials (e.g., sonobuoy cases).

16. On ships equipped with compactors, consider compacting plastic material separate from all other waste.

17. Provide bulk dispensers for commonly used products packaged in personal sized plastic containers.

18. Study the feasibility of hiring a private contractor to collect trash at sea from Navy vessels operating in selected areas.

B. NARRATIVE DISCUSSION OF RECOMMENDATIONS

1. Prior to leaving port, the maximum amount of packing materials and other plastic trash should be offloaded from ships.

Justification: This will minimize the amount of plastic generated for disposal. The degree to which the Navy can minimize the amount of plastic brought on board the ship will have a significant effect on its ability to eliminate the discharge of plastic waste at sea.

What has been done: In some instances, this practice already exists. In addition, Atlantic Fleet ships have already been instructed to attempt to institute this practice.

What needs to be done: Issue an instruction to implement this practice in all instances.

Time frame: Institute immediately.

Responsibility: Navy chain of command.

Cost Estimate: Low

Priority: High

2. Separate plastic trash.

Separate plastic trash from other trash at source on mess decks and other main collection sites. Keep plastic trash, which is contaminated with food residue, separate from plastic trash which is not contaminated. Achieve through use of dual trash receptacles or multi-compartmented trash receptacle.

Justification: This will provide a basic first step for separate handling and disposal of plastic trash without added labor cost. It will reinforce awareness of the problem at all levels.

What has been done: Atlantic Fleet ships have already been instructed to attempt to institute this practice.

What needs to be done: Equip collection sites with suitable receptacles. Institute instruction to separate plastic trash.

Time frame: Institute immediately.

Responsibility: Navy chain of command down through the individual level.

Cost Estimate: Low

Priority: High

3. Store plastic trash for offloading.

Store for offloading plastic trash which is not contaminated with food residues. Until full compliance can be achieved, to greatest extent practicable, store for offloading plastic trash which is contaminated with food residue.

Justification: This will facilitate the ultimate goal of land disposal of plastic trash. The larger the amount of plastic that can be stored, the less the need to manage the plastic in some other way or discharge.

What has been done: Atlantic Fleet ships have already been instructed to attempt to institute this practice.

What needs to be done: Issue instructions to store plastic trash in designated areas.

Time frame: Institute immediately.

Responsibility: Navy chain of command.

Cost Estimate: Low - Medium.

Priority: High

4. Consider storage of used plastic wrapping from foods in closed container in freezer.

Justification: Re-freezing of plastic trash contaminated with food residue will eliminate health hazards and provide sanitary storage until the plastic can be offloaded for proper disposal. Management of plastic contaminated with food residue is expected to be a major concern because a large percentage of the plastic brought on board ship is used as food packaging.

What has been done: No action.

What needs to be done: Determine safety of such storage from public health perspective. Issue instruction to food preparation personnel to re-freeze used plastic from foods products.

Time frame: Make determination prior to initiating

demonstration ship program and, if appropriate, test on demonstration ship.

Responsibility: Approval by Navy Environmental and Preventive Medicine Command. Implement through Navy chain of command.

Cost Estimate: Low

Priority: High

5. Locate plastic waste receptacle on fantail of ship or other trash discharge location.

Justification: This will facilitate retention of plastic trash by providing last opportunity for collection.

What has been done: No action.

What needs to be done: Provide ships with receptacles. Issue instruction to retain plastic at point of discharge.

Time frame: Institute immediately.

Responsibility: Navy chain of command down through the individual level.

Cost Estimate: Low

Priority: High

6. Until full compliance is achieved, determine "no plastic discharge zones" for each class of ship.

Such zones would be areas in which no plastic trash could be discharged. The boundaries of the zones would be determined by the storage capacity of each class of ship within a time frame that enables that class of ship to travel from the offshore edge of the zone to port. Since Navy vessels are currently prohibited from discharging trash within 25 miles of the coast, a "no plastic discharge zone" would extend that prohibition for plastics to a greater distance from shore for those ships with additional storage capacity.

Justification: This will facilitate the retention on board of a larger quantity of plastic than might otherwise be maintained. Minimizes to a limited extent the shoreline impact of discharged plastic.

What has been done: Atlantic Fleet ships have already been instructed to attempt to institute this practice.

What needs to be done: Determine the appropriate "no plastic discharge zone" for each class of vessel. Zones could be defined by "hours from port" or "distance from port" (whichever is further from shore). Issue an instruction to implement the "no plastic discharge zone".

Time frame: Determine "no plastic discharge zone" for each class of vessel within three months; implement immediately thereafter.

Responsibility: Chief of Naval Operations and/or Fleet Command.

Cost Estimate: Low

Priority: High

7. Initiate conservation and reuse/recycling policies on a shipwide basis, especially target shipping and receiving areas.

Includes requirement that plastic be stored in work area for purposes of reuse or recycling.

Justification: This will ensure that reuse or recycling efforts are carried out wherever feasible and will minimize the amount of plastic trash that must be offloaded for land disposal.

What has been done: No action.

What needs to be done: Issue instruction to recycle plastic waste wherever possible.

Time frame: Institute immediately.

Responsibility: Navy chain of command.

Cost Estimate: Low

Priority: High

8. Eliminate plastic liner in trash can.

If necessary, replace metal trash cans with specially coated receptacles to facilitate ease of disposal and cleaning. Install specially coated trash chute on fantail or other discharge location to facilitate discharge of trash without use of plastic.

Justification: Minimize discharge of plastic or other waste material into the sea.

What has been done: No action.

What needs to be done: Investigate feasibility of using receptacles without liners -- if only in selected areas. If necessary, procure new or additional receptacles.

Time frame: Evaluate feasibility on demonstration ship.

Responsibility: Navy chain of command.

Cost Estimate: Low - Medium

Priority: High

9. All Commanding Officers should require that, wherever possible, plastic items (e.g., coffee cups, coffee stirrers) be replaced with non-plastic items and that disposable items used on board ship be replaced with reusable items (e.g., disposable aprons, gloves, dry cleaning bags).

Justification: This will minimize the amount of plastic trash generated on board ship.

What has been done: Atlantic Fleet ships have already been instructed to attempt to institute aspects of this practice.

What needs to be done: Complete evaluation and, on that basis, Navy should notify suppliers of needs and institute use on board ship.

Time frame: Begin evaluation immediately for testing on demonstration ships.

Responsibility: Naval Supply Systems Command and Commanding Officers.

Cost Estimate: Low - Medium (depending on item)

Priority: High

10. Designate Environmental Officer (on collateral duty) for each ship to integrate responsibility for all

environmental systems, including collection, holding and transfer (sewage) system, hazardous materials/hazardous waste systems and trash disposal.

Justification: Effective pollution control can best be achieved if an officer is delegated responsibility for that task. The importance of pollution control will be greatly enhanced by the designation of such an officer. Dedicated effort to address pollution systems in a more comprehensive way is necessitated by increasing legislative requirements over the years for all waste disposal activities. The technology applied to these systems is more advanced and complex and crosses many disciplines. A high level of expertise and coordination is required to comply with legislative mandates.

What has been done: No action.

What needs to be done: Concept paper drafted by the Chief of Naval Operations staff.

Time frame: Submit concept paper within three months. Process within one year.

Responsibility: Chief of Naval Operations.

Cost Estimate: Medium

Priority: High

11. **Determine capacity for storage of plastic trash for each class of ship, beginning with demonstration ship.**

Justification: This will provide a basis for determining the ability of the ship to store plastic trash for offloading, and the consequent need to further minimize onloading of plastic, or the need for special equipment. Sets a standard to be achieved by each ship.

What has been done: No action.

What needs to be done: Each class of ship must be surveyed to identify potentially available storage space. Such space should be allocated for storage of plastics on board demonstration ships to evaluate its suitability for storage.

Time frame: Begin survey immediately for application to demonstration ships.

Responsibility: David Taylor Naval Research Center (as part of the Ship Waste Plastics Control Demonstration Project).

Cost Estimate: Medium

Priority: High

12. **Evaluate the feasibility of sanitizing plastic trash and subsequent storage on board ship.**

Explore possibilities for sanitizing plastic trash on board ship (e.g., steam cleaning, flushing with seawater).

Justification: Long-term storage of plastic contaminated with food residue poses potential health problems and such plastic, therefore, requires special treatment or handling. The benefits of implementing this recommendation will be proportional to the percentage of plastic trash contaminated with food residue. Since this percentage is expected to be quite high, the benefit of pursuing this course of action is also expected to be high. The Committee acknowledges that this approach may be labor intensive, but believes it presents an important opportunity to reduce marine plastic pollution and deserves the Navy's attention.

What has been done: The feasibility of sanitizing plastic trash is currently being evaluated as part of the Ship Waste Plastics Control Demonstration Project conducted by the David Taylor Naval Research Center.

What needs to be done: Data should be gathered to determine: (1) the extent of the need (volume of plastic) for special equipment or measures; (2) the feasibility of instituting operational measures or installing equipment; (3) the effectiveness of such measures or equipment.

Time frame: Initiate efforts immediately and identify any suitable operational measures within one year. If special equipment is needed, adjust time frame in accordance with the nature of the equipment.

Responsibility: David Taylor Research Center for Ship Waste Plastics Control Demonstration Project on sanitization.

Cost Estimate: Low capital cost; potentially high costs depending on labor requirements and the need for special equipment.

Priority: High

13. **Until full compliance is achieved and the Act takes effect for Navy vessels, each vessel should maintain a ship's log for recording all discharges of trash. The Navy should develop a system for using this data to measure progress in achieving compliance with the legislation.**

Record of all discharge of trash should include an annotation as to whether plastic waste was discharged. The Navy should develop a data collection system and a regular reporting mechanism to utilize the information collected and integrate information in the Navy's annual report to Congress.

Justification: This provides the basis for measuring progress in achieving compliance with the legislation. Currently, the Navy has no system to collect such data and report on progress made to Congress. This will provide valuable information about plastic trash generated on board Navy vessels.

What has been done: No action.

What needs to be done: Commanding Officers should issue instructions to maintain a log of plastic waste discharge and the Navy should establish a system for measuring compliance with the legislation.

Time frame: Institute immediately.

Responsibility: Navy chain of command.

Cost Estimate: Low

Priority: High

14. **Evaluate storeroom designs and operating procedures to facilitate storage of plastic trash.**

Evaluate storeroom designs and operating procedures (such as the potential for more effective use of ceiling spaces and storage in shipping/receiving areas; backfilling plastics behind active stock; the use of mechanical shelving units for storage of supplies and/or plastic trash, etc.) to determine whether the current system can be altered.

Justification: This facilitates efficient use of space for storage of plastic trash without impeding access that might otherwise remain unused.

What has been done: No action.

What needs to be done: Initiate evaluation.

Time frame: Initiate evaluation immediately.

Responsibility: Naval Supply Systems Command (Fitting Out and Supply Support Assistance Center).

Cost Estimate: Medium

Priority: Medium (depends on storage capacity)

15. **Evaluate use of supply ship for offloading of certain plastic trash, pallets and reusable items or materials (e.g., sonobuoy cases).**

Justification: Using supply ships to offload plastic trash has limitations. However, they may provide a useful option in selected situations -- especially for classes of ships where there is minimal storage capacity for plastics or reclamation of reusables. The benefits of implementing this recommendation will vary greatly by class of ship.

What has been done: The Navy has undertaken an evaluation of the use of supply ships for offloading all plastic trash.

What needs to be done: Evaluate the use of supply ships for offloading of limited kinds/quantities of plastic trash, or offloading plastic trash under certain specified circumstances (e.g., ship has been at sea for extended period of time, to service ships which have minimal storage capacity). Identify target items for potential offloading to supply ships (e.g., sonobuoy cases).

Time frame: One year for completion of evaluation.

Responsibility: Type Commanders Combat Logistics Force Staff.

Cost Estimate: Medium - High

Priority: Medium

16. On ships equipped with compactors, consider compacting plastic material separate from all other waste.

Justification: Compactor will reduce the volume of plastic for storage. Plastic trash contaminated with food residue poses a potential health hazard requiring special storage considerations.

What has been done: No action.

What needs to be done: Once compactor has been installed, issue appropriate instructions.

Time frame: Immediately for demonstration ship and immediately upon installation of compactor for all other vessels.

Responsibility: Operators of compactors.

Cost Estimate: Medium

Priority: Medium.

17. Provide bulk dispensers for commonly used products packaged in personal sized plastic containers.

Justification: This will eliminate the overall number and variety of small plastic items in need of disposal.

What has been done: No action.

What needs to be done: Identify items that may be dispensed in bulk; investigate bulk procurement of identified items; test on demonstration ship.

Time frame: Immediately for testing on demonstration ships.

Responsibility: Naval Supply Systems Command (Navy Resale and Services Support Office)

Cost Estimate: Medium - High

Priority: Medium

18. Study the feasibility of hiring a private contractor to collect trash at sea from Navy vessels operating in selected areas.

Specifically investigate the use of private contractor for collecting recyclable materials and plastic trash in selected areas (e.g., offshore of the U.S., Europe).

Justification: In the long term, the Navy may benefit from contracting out for collection of trash, especially recyclables such as aluminum and glass that may substantially increase in value in the future.

What has been done: No action.

What needs to be done: Feasibility study.

Time frame: Feasibility study completed in three years.

Responsibility: Naval Facilities Engineering Command.

Cost Estimate: Medium - High

Priority: Low (in the short term).

V. EDUCATION

In the next few months, the U.S. Navy will test new equipment and shipboard practices to prevent the disposal of plastic trash at sea. Ultimately, such procedures and equipment will come into use throughout the fleet. For these efforts to be successful, crew members and others must understand the basis for these actions. They must be made aware of the fact that the Navy has a Congressional mandate to comply with the provisions of Annex V of the MARPOL Treaty within the next five years, and more importantly, they need to understand the reasons for this mandate. Navy crew members and others need to learn about the problems caused by the disposal of plastics in the marine environment, including the threat plastics pose to marine wildlife and must be informed about how they can become part of the solution.

A program that explains these and other aspects of the marine debris problem is essential to the success of the Navy's plan to reduce the disposal of plastic trash in the marine environment. Changes in attitudes and behaviors of naval personnel will determine whether the Navy's plan will be successful, and such changes can only be achieved through a well coordinated education plan.

The development of education programs must evolve relative to changes in supply, operations and technology. Therefore, although a general time frame has been assigned to the recommendations in this section, education activities should be developed along with the Navy's general plan to address this problem. Ideally, all of the following recommendations, particularly those pertaining to ships, should be applied fleetwide by 1993. However, all educational materials and methods developed for the Navy should be periodically reviewed and updated to maintain their effectiveness.

At this time, it is also difficult to estimate costs for many of the following recommendations. Many activities will only involve the costs of time spent by Navy personnel. In addition, the benefits of such recommendations, in terms of overall plastic waste reduction, cannot be measured at this time. However, as noted above, without some attempt to inform and educate naval personnel about the plastic debris problem and the Navy's plan to address this problem, their cooperation cannot be fully achieved.

The following recommendations suggest ways the Navy can incorporate education into its plan to reduce the disposal of plastics in the marine environment. Priority has been assigned to each recommendation based on the order in which each task should be addressed and the importance of each task relative to other recommendations in this section.

A. SUMMARY OF EDUCATION RECOMMENDATIONS

1. Information on the plastic debris problem and the Navy's plan to address this problem should be disseminated to all levels of the Navy.

2. Educational materials on the plastic debris problem and the Navy's plan to address this problem should be developed for ships, naval supply centers, and offices involved in procurement.

3. Every Navy vessel should use an education package composed of several key elements.

4. The effectiveness of education efforts on ships should be assessed through a survey.

5. The Navy should use the Environmental Award as a means to recognize ships that are outstanding in their efforts to reduce plastic wastes.

6. Naval vessels should consider sponsoring shipboard contests on plastics reduction methods.

B. NARRATIVE DISCUSSION OF RECOMMENDATIONS

1. Information on the plastic debris problem and the Navy's plan to address this problem should be disseminated to all levels of the Navy.

   Justification: Cooperation at all levels will be needed if the Navy's plan to reduce plastic debris is to be successful. For example, those who must begin procedures to minimize the amount of plastics in supply, those who must take precautions in separating plastic wastes from the ship's waste stream, and those who will be in charge of supervising these efforts and allocating funds for these projects need to know why such measures are important. The initial process of sensitizing Navy personnel to the issue of plastic debris will facilitate the acceptance of later steps taken by the Navy to address this problem. Regular updates on the Navy's progress will help maintain interest. The eventual development of programs to be incorporated in training programs will help to prepare Navy personnel about what they will be required to do to reduce plastic waste disposal at sea.

   - What has been done: Only a small segment of the Navy, including personnel who are involved with the Ad Hoc

Advisory Committee on Plastics and others aware of the activities of this group, have been introduced to the plastic debris issue. Broad-based information and education activities have not yet taken place.

What needs to be done:

Phase I: The Navy must begin to disseminate information on the plastic debris issue through various media including the Navy Times, Navy News This Week, the Armed Forces Information Service and other general avenues. These efforts should emphasize that: 1) plastics pose a threat in the marine environment; 2) Congress has directed the Navy to come into compliance with Annex V within the next five years, and; 3) the Navy has made a commitment to reduce plastic disposal at sea and is developing a plan to carry this out, and intends to pursue this effort with Navy pride in leadership. In addition, information should be provided on what other marine user groups, such as the commercial fishing and merchant shipping industries, are doing to reduce plastic disposal at sea.

Phase II: Information on the results of test ships, technological developments, and other progress to reduce plastic disposal at sea should be disseminated to Navy personnel, through the media discussed above.
Phase III: Information on the plastic debris problem and what the Navy has done to address this problem should be included in boot camp training, Officer's Candidate School, Navy ROTC programs, the Navy Academy and other avenues.

Time frame: The above information/education process should commence immediately and be a continuing process thereafter.

Responsibility: Chief of Naval Operation, Chief of Naval Education and Training, Fleet Commander and Chiefs.

Cost Estimate: Staff time to write articles for distribution to Navy media.

Priority: High

2. Educational materials on the plastic debris problem and the Navy's plan to address this problem should be developed for ships, Naval Supply Centers and offices involved in procurement.

Justification: Navy ships, supply centers and offices involved in procurement will be most affected by the Navy's plan. Therefore, educational materials should be developed specifically for these groups.

What has been done: The development of an education program for Navy vessels, supply offices and offices involved with procurement began in May, 1988.

What needs to be done:

Phase I: Since the Navy will be using several ships to test new supply, operation and technological strategies to address the plastic debris problem, these ships should also test educational efforts for crew members. Any form of education would have to coincide with other matters being tested on the ship so that sailors are not confused by suggestions that are beyond their control or the ability of the test ship. In addition, emphasis should be given to promoting plastics awareness with those officers who will be overseeing plastic waste reduction programs.

Education efforts should include information on the problem, what is being done to address the problem, and what individual ships and their crew members can do to help. Information on entanglement in and ingestion of plastics by marine life should be included in addition to other problems caused by plastics such as aesthetic degradation and vessel disablement. Materials should convey that this is a global problem (include examples of plastics accumulating even in remote areas of Antarctica, etc.). (See Recommendation #3 for list of specific educational materials to be used on board ships.)

The Naval Supply Centers and offices involved with procurement for these test ships should also be used as models for the development of educational materials. In this case, informative and attractive posters would be useful. It is suggested that the poster "Our Ocean It's Drowning.", developed by the National Marine Fisheries Service Marine Entanglement Research Program, be used. This poster could be framed and permanently mounted. However, an alternative poster should be developed for these offices.

All materials should be low-keyed, professional and sincere. The primary purpose of education is to explain why it is important to prevent the disposal of plastics in the marine environment and what an individual can do to become part of the solution

Phase II: Once educational materials have proved to be successful on test ships and model Navy supply and procurement offices (see recommendation #4), these materials should be produced for fleetwide distribution.

Time frame: By December 1988, the Navy should finalize development of materials that will be used for widespread distribution and begin production of these materials.

Responsibility: Chief of Naval Operations, Systems Commands, Fleet Commander and Chiefs.

Cost Estimate: Printing and staff time to oversee development and implementation of education plan.

Priority: High

3. **Every Navy vessel should use an education package composed of several elements.**

Justification: Navy vessels are a direct source of plastic wastes. Therefore, the greatest amount of effort in terms of education should be placed on educating crew members. Educational materials should inform crew members about the problem and what they are required to do on board. Materials, such as video announcements, posters, bumper stickers, and placards provide a long-term mechanism for reinforcement of these ideas.

What has been done: No action.

What needs to be done: The following materials should be developed for inclusion in an education package, listed in order of priority:

a. **Fact Sheet** -- It is important to prepare a fact sheet (2-3 pages in length) on the problem for those that will have to answer questions from crew members, or for those that just want to know more.

b. **"Plan of the Day" Announcements** -- Each ship prints and posts its own "Plan of the Day" which is a type of newsletter. When a ship is at sea, this is often one of the only forms of outside information available to a sailor. The Navy should distribute information on plastics to all ships and request that it be printed in the "Plan of the Day". This should consist of a series of very brief articles on the

subject that should be printed in the Plan at regular intervals. This information would have to be short (2-5 lines per issue), informative and interesting. These can easily be taken from the above fact sheet or articles produced in Recommendation #1

c. **Video** -- A video program (8-10 minutes) should be shown before full-length movies, or incorporated into short training sessions. Such a video would give information on the problems caused by the disposal of plastics in the marine environment followed by an explanation of what their ship is doing to reduce the disposal of plastics at sea and what individual crew members should do as part of these efforts. The Committee has agreed to prepare part of the script on explaining the problem. Navy staff should prepare the portion of the video describing what is being done on board ships to combat the problem.

The Navy has a special unit that makes videos, the Naval Imaging Command. To expedite the production of this video, the Committee is investigating the availability of video footage on the plastic debris problem from contractors of the National Marine Fisheries Service Marine Entanglement Research Program and local television stations. Such footage could be used and adapted to meet a Navy audience.

d. **Video Announcements** -- In addition to the video described above, short video announcements (30 seconds to one minute in duration) should be produced and shown at regular intervals on board ships. These announcements would explain a specific problem caused by plastics in the marine environment. Four such videos should be produced with the following messages:

(1) **Plastic debris harms marine wildlife**-- Describe the harmful effects of plastic debris on marine wildlife due to entanglement in and ingestion of plastics.

(2) **Plastic debris is a persistent eyesore**-- Describe the aesthetic degradation of shorelines and the open ocean caused by the accumulation of plastic debris. Emphasize the fact that plastics are different than other types of trash because of their light weight, strength and durability.

(3) **Plastic debris poses a threat to navigation**-- Describe the problems of vessel disablement caused by plastic debris such as ropes, lines,

bags and sheeting that can foul props and clog cooling water intakes and evaporators. This is a problem for all seafarers (naval, commercial, recreational, etc.).

(4) Plastic debris is a matter of reputation and sailors should "take pride" in what they are doing to combat this problem -- The public and others are becoming increasingly aware of the specific sources of plastic debris and to what degree these sources are attempting to reduce their contribution to this problem. The Navy is taking a lead role in finding practical solutions to this problem -- solutions that are not just applicable to Navy, but solutions that will assist all marine vessels and user groups in finding ways to reduce plastic waste disposal at sea.

e. Posters - Posters should be placed in key areas of the ship where plastics are generated and discarded. These posters should be art work of an entangled animal with a short caption (i.e., Picture: of sea turtle with plastic bag in mouth. Caption: "A vessel tossed out some garbage and killed this turtle"). Four such posters should be developed with the following pictures:

(1) sea turtle with plastic bag in mouth
(2) seal with plastic strapping band around neck
(3) fish entangled in plastic six-pack ring
(4) bird either entangled or with plastic in stomach

It should be noted, however, that in certain areas such as dining halls, the posters described above may not be appropriate.

f. **Mounted Display** - A display using pictures with written captions should be developed and used on board larger ships. This display should show examples of the impact of plastics on marine wildlife and provide information on what is being done on board a ship to prevent plastic disposal at sea.

g. **Bumper Stickers on Operational Guidance**-- Stickers that remind sailors not to throw plastics overboard should be posted in prime areas of the ship such as on garbage cans, in the galley, mess halls and supply rooms.

h. Placard -- A placard, similar to those pertaining to oil discharges, should be posted at the station of

the Duty Officer. This placard should notify the crew of the requirements of Annex V. The U.S. Coast Guard is presently designing such placards for commercial and recreational vessels.

Time frame: Educational materials should be used first on test ships. Materials for fleetwide distribution should be finalized and ready for production by December 1988.

Responsibility: Fleet Commander and Chiefs

Cost Estimate: Development and production of materials and staff time.

Priority: High

4. The effectiveness of education efforts on ships should be assessed through a survey.

Justification: Well written surveys will indicate whether educational efforts are effective and help in the development of a strong education plan.

What has been done: No action.

What needs to be done:

Phase I: Crew members on board test ships should be given a "pre-test" survey before educational materials are used to determine the level of awareness of the problems caused by plastic debris and general feelings toward preventing the disposal of plastics at sea (e.g., do they think it is a problem to dispose of plastics at sea, how would they respond if asked to separate and store plastic trash on board for disposal in port). The results of this survey would be evaluated against a "post-test" survey to determine whether attitudes and behaviors were changed due to educational efforts. In addition, crew members would be encouraged to evaluate the materials used (what did they like, dislike, need more of, need less of, etc.).

Phase II: Once educational efforts are applied fleetwide, spot check surveys should be conducted periodically to provide a regular check on the effectiveness of educational materials and methods in order to determine where changes are necessary.

Time frame: Begin development of surveys for test ships immediately. Surveys for distribution fleetwide should be completed by December 1993.

Responsibility: Chief of Naval Operations, Chief of Naval Education and Training, Fleet Commander and Chiefs.

Cost Estimate: Staff time to design survey and compile and analyze results.

Priority: High

5. The Navy should use the Environmental Award as a means to recognize ships that are outstanding in their efforts to reduce plastic wastes.

Justification: Awards offer an additional incentive to comply with the task of reducing plastic disposal at sea. For very little cost and effort, the Environmental Award will provide the Navy a means to reward ships that are outstanding in their efforts to reduce plastic debris and will offer the Navy an additional opportunity to assess its efforts to address the problem. In addition, it will provide means for the Navy to publicize its success both within the Navy and to outside groups.

What has been done: Each year, the Navy gives an Environmental Award to one small ship and one large ship. Winning ships fly the white and green environmental flag.

What needs to be done: Preventing discharges of plastic waste should become a criterion for the Environmental Award, and ships that are outstanding in their efforts should be rewarded.

Time frame: To be implemented in 1990.

Responsibility: Chief of Naval Operations.

Cost Estimate: Staff time of those who administer the Environmental Award.

Priority: Medium

6. Naval vessels should consider sponsoring shipboard contests on plastics reduction methods.

Justification: Contests offer an additional means of education and help to create incentives for sailors to reduce plastic waste disposal at sea.

What has been done: No action.

What needs to be done: Each ship should consider conducting a contest on plastic reduction methods among all departments of the ship. Contests could also be conducted between different ships of the same class. The group or ship that is most outstanding in their efforts could be given a suitable reward to be determined by Navy staff.

Time frame: Contests could begin on test ships in 1988. By 1990, this should be encouraged fleetwide.

Responsibility: Fleet Commander and Chiefs

Cost Estimate: Staff time

Priority: Medium

APPENDIX A

AD HOC ADVISORY COMMITTEE ON PLASTICS
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APPENDIX B

GLOSSARY OF TERMS

1. **Armed Forces Information Service** - the public information service for the armed forces.
2. **Chief of Naval Education and Training** - the officer responsible for administering the Navy's education and training programs.
3. **Chief of Naval Operations** - senior military officer in the Navy.
4. **David Taylor Research Laboratory** - a Navy laboratory researching and developing technologies for various Navy areas of interest.
5. **Defense Logistics Agency** - the organization that oversees purchasing and distribution of items common to all United States Armed Forces, not exclusively single service (like, Navy) use items.
6. **Duty Officer** - a generic title for an officer in the execution of responsibilities to further the command's mission in a role other than the officer's specific administrative assignment, such as the officer representing the commanding officer after the work day is over and the commanding officer has gone home.
7. **Natick Laboratory** - military research and development laboratory related to food and clothing.
8. **Naval Environmental and Preventive Medicine Command** - the Navy's equivalent to a public health agency.
9. **Naval Facilities Engineering Command** - the systems command responsible for facilities and military construction engineering and also some environmental issues.
10. **Naval Fleet Command** - there are two fleet commands. One is the Pacific and the other is the Atlantic Fleet Command. The two commands divide responsibility for Navy ships and aircraft based on the location of the ships or aircraft within the geographic area of responsibility of either the Commander of the Pacific or Atlantic Fleet Commands. The Fleet Commanders are the intermediary administrative command between the Chief of Naval Operations (CNO) and the Type Commanders (TYCOM).
11. **Naval ROTC Program** - a Navy training program for future officers enrolled in colleges and universities.
12. **Naval Supply Centers** - regional purchasing and distribution centers located in the United States.
13. **Naval Supply Depots** - overseas purchasing and distribution centers.
14. **Naval Sea Systems Command** - the organization that designs and builds ships and submarines and subsystems, like propulsion or weapons systems, for the ships and submarines.
15. **Naval Supply System Command (NAVSUP)** - the organization that oversees purchasing and distribution of supplies for the Navy.
16. **NAVSUP FOSSAC** - subordinate command under Naval Supply Systems Command (NAVSUP) and responsible for storeroom and warehouse design and distribution systems.
17. **NAVSUP NAVRESSO** - subordinate command under NAVSUP responsible for retailing personal convenience items.
18. **OPNAV** - the organization that carries out the mission of the Office of the Chief of Naval Operations.
19. **Systems Command** - other systems commands provide the management for aircraft and research laboratories.
20. **TYCOM** - the administrative commander of a single type of Naval unit (e.g., aircraft carriers, submarines, or other surface vessels). The officer responsible for administrative rules, training and maintenance for all Naval units of the type, e.g., all aircraft carriers. Works for and under the respective Fleet Commanders.

DR. DAVID S. BUCKNER

DIRECTOR, OFFICE OF SOLID WASTE AND RENEWABLE RESOURCES

ILLINOIS DEPARTMENT OF ENERGY AND NATURAL RESOURCES

MR. CHAIRMAN AND RESPECTED MEMBERS OF THIS COMMITTEE, THE STATE OF ILLINOIS THANKS YOU FOR THIS OPPORTUNITY TO PRESENT ITS PROGRAMS AND VIEWS ON THE ISSUE OF SOLID WASTE MANAGEMENT AND FOR THE OPPORTUNITY TO COMMENT ON S2262: THE AGRICULTURAL COMMODITY-BASED PLASTICS DEVELOPMENT ACT OF 1988.

TO LEND A PERSPECTIVE TO THESE COMMENTS, ILLINOIS DISPOSES OF SOME 52 MILLION CUBIC YARDS OF MUNICIPAL SOLID WASTE (MSW) EACH YEAR. 95 PERCENT OF THAT WASTE IS LANDFILLED AT SOME 146 LANDFILLS ACROSS THE STATE, 3% IS INCINERATED AT THE ONE MSW FACILITY IN ILLINOIS AND AROUND 2% IS RECYCLED. IT IS ESTIMATED THAT WE HAVE BETWEEN 4 AND 6 YEARS REMAINING IN TOTAL LANDFILL CAPACITY, AT CURRENT DISPOSAL RATES.

IN SEPTEMBER 1986, GOVERNOR JAMES THOMPSON SIGNED INTO LAW THE ILLINOIS SOLID WASTE MANAGEMENT ACT (P.A. 84-1319). THAT LAW ESTABLISHED (AS POLICY) ADDRESSING WASTE DISPOSAL VIA THE NOW FAMILIAR HIERARCHY OF WASTE ALTERNATIVES--WASTE REDUCTION AT THE SOURCE, RECYCLING, INCINERATION WITH OR WITHOUT ENERGY RECOVERY AND LANDFILLING. IN PRACTICE, WE BELIEVE THAT THESE ELEMENTS ARE LESS A MANDATORY HIERARCHY TO BE APPLIED IN STRICT ORDER, THAN THE COMPONENTS OF A WASTE MANAGEMENT SYSTEM; TO BE APPLIED IN AN ENVIRONMENTALLY SOUND AND ECONOMICALLY PRUDENT MANNER ON THE LOCAL LEVEL. WE SHOULD NOTE THAT, IN ILLINOIS, THE SITING AND IMPLEMENTATION OF WASTE MANAGEMENT FACILITIES AND METHODS IS DONE ON THE LOCAL GOVERNMENTAL LEVEL; NORMALLY THE COUNTY.

THAT PLACEMENT OF THE WASTE MANAGEMENT DECISION AT THE LOCAL LEVEL WAS FORMALIZED IN 1982 BY P.A. 82-682 WHICH ESTABLISHED A SITING PROCESS WHICH ALLOWS THE APPROPRIATE UNIT OF LOCAL GOVERNMENT TO ASSESS SITES ON THE BASIS OF EIGHT CRITERIA AND TO "JUST SAY NO" TO LANDFILL SITING SHOULD THE LOCAL GOVERNMENT BELIEVE ONE OR MORE OF THE CRITERIA TO BE UNMET. AS A RESULT, SINCE 1982 FEWER THAN 5 NEW LANDFILLS HAVE BEEN APPROVED FOR SITING.

THE SOLID WASTE MANAGEMENT ACT ALSO PUT IN PLACE LANDFILL PLANNING, RECYCLING, MARKET DEVELOPMENT FOR RECYCLABLES, DEMONSTRATION, SITING AND TECHNICAL ASSISTANCE PROGRAMS. IT ALSO PROVIDED FOR DELEGATION OF LANDFILL REGULATION ENFORCEMENT TO LOCAL GOVERNMENTS AND FUNDING FOR AN EXISTING INDUSTRIAL MATERIALS EXCHANGE PROGRAM. IN GENERAL, THE LAW PROVIDED AN EXCELLENT FOUNDATION FROM WHICH TO BEGIN ADDRESSING SOLID WASTE BEFORE AN ABSOLUTE CRISIS STAGE IS REACHED IN ILLINOIS.

THE PROGRAMS REQUIRED IN THE LAW WERE TO BE FUNDED BY A GRADUATED SCALE TIPPING FEE WHICH WOULD GENERATE APPROXIMATELY $ 12 - 14 MILLION PER YEAR. SHORTLY AFTER SIGNING, THE LAW WAS CHALLENGED AND THE FEE PROVISIONS WERE DECLARED UNCONSTITUTIONAL. THE MATTER REMAINS BEFORE THE ILLINOIS SUPREME COURT.

THAT CONSTITUTIONAL "PROBLEM" DID NOT STOP ACTION. THE STATE HAS FUNDED SEVERAL COUNTY PLANNING EFFORTS AND SOME 48 SEPARATE RECYCLING PROGRAMS. WE HAVE PURSUED AS AGRESSIVELY AS POSSIBLE THE DEVELOPMENT OF MARKETS FOR OUR RECYCLABLES AND HAVE AFFORDED "HOW TO" TECHNICAL ASSISTANCE TO HUNDREDS OF INDIVIDUALS, NOT FOR PROFIT GROUPS AND UNITS OF LOCAL GOVERNMENT. AS AN EXAMPLE, A SERIES OF WORKSHOPS FOR LOCAL GOVERNMENT OFFICIALS HAS ATTRACTED SOME 450 PARTICIPANTS.

ON THE WHOLE, ACTION ON THE PART OF "LOCALS" HAS OUTPACED STATE EFFORTS BUT HAS BEEN CURTAILED BY STATE FUNDING SHORTFALLS. IN 1987 WE SOLICITED RECYCLING GRANT APPLICATIONS AND RECEIVED 35, 11 OF WHICH HAD MERIT. IN 1988, WE SOLICITED GRANT REQUESTS AGAIN AND RECEIVED 70, 30 OF WHICH HAD MERIT.

NEW LEGISLATIVE ACTION

THE MOST RECENT LEGISLATIVE SESSION, ENDING JUNE 30, 1988, WAS, BY RULE, TO ADDRESS ONLY THE ANNUAL STATE BUDGET AND LEGISLATION OF AN EMERGENCY NATURE. (ODD YEARS ARE NORMALLY RESERVED FOR "SUBSTANTIVE" ISSUES.) EVEN WITH THAT PROHIBITION, SOME 30 SOLID WASTE RELATED MEASURES WERE INTRODUCED AND EVENTUALLY BOILED DOWN TO SIX KEY BILLS. ALL PASSED, FOUR HAVE BEEN APPROVED BY GOVERNOR THOMPSON, TWO HAVE BEEN SUBJECTED TO THE GOVERNOR'S AMENDATORY VETO AND ARE EXPECTED TO BE APPROVED IN THE FALL.

LEGISLATION DOES THE FOLLOWING:

1) REESTABLISH, INCREASE AND MAKE PERMANENT THE STATE TIPPING FEE SURCHARGE, REPLACING THAT CHALLENGED IN THE COURTS (P.A. 85-1195)

2) REQUIRE THE DEVELOPMENT AND IMPLEMENTATION THEREAFTER OF SOLID WASTE PLANS IN OUR MOST POPULOUS COUNTIES AND THE CITY OF CHICAGO BY 1991. A 25% RECYCLING GOAL IS A PART OF THE PLAN REQUIREMENT (P.A. 85-1198)

3) REMOVE BY JULY 1990 LANDSCAPE WASTE FROM OUR LANDFILLS AND REQUIRE SOURCE SEPARATION AND COMPOSTING OF THE MATERIAL--INCLUDING DISPOSAL IN BIODEGRADABLE CONTAINERS (AMENDATORY VETO)

4) ESTABLISH HEIGHTENED RECYCLING AND COMPLEMENTARY PROCUREMENT PROGRAMS WITHIN STATE GOVERNMENT WITH COST DIFFERENTIAL FUNDING TO COME FROM THE SALE OF THE COLLECTED RECYCLABLE MATERIALS. (P.A. 85-1196 AND P.A. 85-1197)

5) REQUIRE THE LABELING, BY RESIN TYPE, OF PLASTIC CONTAINERS BY JANUARY 1990 (P.A. 85-1198).

ON BALANCE, WE BELIEVE ILLINOIS IS WELL POSITIONED TO BEGIN ADDRESSING THE SOLID WASTE ISSUE WITHIN OUR OWN BORDERS.

I WOULD LIKE TO TURN NOW, TO ISSUES OF BROADER CONSEQUENCE.

WE IN ILLINOIS ARE CONCERNED ABOUT MANY ISSUES IN THE WASTE MANAGEMENT AREA. LANDFILL DESIGN, INCINERATOR EMISSIONS AND ASH DISPOSAL ARE IMPORTANT CONSIDERATIONS. IN GENERAL, THE ISSUE WITH THESE ALTERNATIVES FOCUSES ON THE FACT THAT WHEN WE BUILD ANYTHING PROBLEMS CAN ARISE AT THREE POINTS. THOSE POINTS ARE 1) INITIAL DESIGN, 2) CONSTRUCTION AND 3) OPERATION/MAINTENANCE. FAILURE AT ANY ONE OF THOSE THREE POINTS WILL CAUSE GRAVE ENVIRONMENTAL AND ECONOMIC CONSEQUENCES. WE BELIEVE THE POTENTIAL FOR WASTE MANAGEMENT SYSTEM FAILURE IS GREATEST AT THESE MOST TECHNICAL ALTERNATIVES.

FURTHER, IN TERMS OF THE SYSTEMS APPROACH TO SOLID WASTE MANAGEMENT, EMPHASIS IS GIVEN TO WASTE REDUCTION AND RECYCLING. LET US ADDRESS THE PRINCIPAL RECYCLING CONCERNS, FIRST.

OUR BELIEF, BASED ON THE ACTIVITIES WE SEE OCCURRING, IS THAT RECYCLING COLLECTION WILL GROW RAPIDLY--FUELED BY PUBLIC NEED AS WELL AS WISH. THIS GROWTH, OF COURSE, GIVES RISE TO CONCERN OVER MARKETS FOR RECYCLABLES.

IT IS CERTAINLY NO NEWS THAT THERE IS WORRY ACROSS THE NATION THAT A GLUT OF MATERIALS MAY DRIVE THE PRICE SO LOW AS TO DESTROY RECYCLING OPERATIONS. THERE IS AN OLD SAW IN THE SCRAP BUSINESS THAT SCRAP MATERIALS ARE BOUGHT, NOT SOLD. HAVING THEM DOESN'T GUARANTEE A MARKET. THERE ARE ANSWERS FOR SOME PARTS OF THE NATION, BUT PERHAPS NOT ILLINOIS IN TERMS OF ACCESSING INTERNATIONAL MARKETS. BUT WHY ARE WE SHIPPING VALUABLE RESOURCES OVER SEAS, ONLY TO HAVE TO REPURCHASE THEM AS HIGHER PRICED "VALUE ADDED" PRODUCTS? THERE ARE CONCERNS IN ENCOURAGING, INDEED, DEMANDING PROCUREMENT RECYCLED MATERIAL-BASED PRODUCTS AND REDUCING THE WASTE PRODUCED.

WE BELIEVE THAT GLASS AND ALUMINUM MARKETS ARE STRONG AND WILL CONTINUE TO BE SO. ALL THE DATA SEEMS TO INDICATE ROOM FOR GROWTH OR A LEAST MARKET STABILITY. WHATEVER THE CASE, THESE ELEMENTS COMPRISE A VERY SMALL PORTION OF THE SPACE IN A LANDFILL.

THE REALLY TROUBLESOME COMPONENT OF THE WASTE STREAM IS PLASTIC. FIRST, IT IS SAID THAT PLASTICS COMPRISE AROUND 8% BY WEIGHT OF WHAT GOES INTO OUR LANDFILLS. BUT OUR LANDFILLS ARE NOT "OVER WEIGHT". THEY ARE BECOMING BLOATED AND RAPIDLY FILLING UP. FURTHER, PLASTICS COMPRISE AROUND 25% BY VOLUME OF WHAT GOES INTO LANDFILLS, AND A VERY TROUBLESOME 25% AT THAT.

AS PLASTICS CONTINUE TO GROW IN THE WASTE STREAM, THE ISSUE OF THEIR CONSEQUENCE IN LANDFILLS WILL BECOME MORE A FACTOR IN THE SYSTEMS APPROACH TO SOLID WASTE MANAGEMENT. AND WHERE ARE WE TODAY?

POST-CONSUMER PLASTICS RECYCLING IS FAR FROM A REALITY IN AMERICA. THE NEW YORK TIMES REPORTED (AUG. 30, 1988) THAT LESS THAN 1% OF PLASTICS IS RECYCLED. YET PLASTICS COMPRISES THE SECOND LARGEST AND BY ALL ACCOUNTS THE MOST RAPIDLY GROWING SEGMENT OF THE WASTE STREAM. THE CHALLENGE THEN, IS HOW TO OPTIMIZE THE USE OF PLASTIC AND TO MINIMIZE THE AMOUNT WHICH ENTERS WASTE STREAM AND ALSO MINIMIZE THE IMPACT OF THAT WHICH WILL ENTER THE WASTE STREAM. A PART OF THE SOLUTION TO THIS MULTI-EQUATIONED PROBLEM MAY BE IN DEGRADABLE PLASTICS.

DEGRADABLE PLASTICS

AT THE PINNACLE OF INTEREST TODAY IS DISCUSSION OVER DEGRADABLE PLASTICS. LET US CAUTION, THE PINNACLE OF INTEREST IS NOT THE SAME AS THE FOUNDATION OF THE SOLUTION. SOME BELIEVE THAT CREATING PLASTICS WHICH DETERIORATE IN THE OPEN AIR OR DEGRADE IN THE LANDFILLS WILL SOLVE THE PROBLEM. ILLINOIS BELIEVES THAT STATEMENT TO BE TOO BROAD. FIRST, WE HAVE EVIDENCE FROM OUR OWN LANDFILLS THAT NEWSPAPERS AND EVEN MEATS DO NOT NECESSARILY DECAY AFTER 12 YEARS.

SECOND, I RETURN TO THE EARLIER POINT. ONCE THE LANDFILL REACHES CAPACITY BECAUSE OF THE SHEER VOLUME OF MATERIALS DEPOSITED TODAY IT MATTERS LITTLE THAT THEY WILL DEGRADE IN SIX MONTHS OR A YEAR OR 5 YEARS OR 500. THE LAND HAS BEEN USED AND THE SEARCH WILL HAVE--LONG SINCE--BEGUN FOR MORE LAND. ON THE OTHERHAND, WE DO BELIEVE THAT THERE IS A VERY IMPORTANT ROLE TO BE PLAYED BY BIODETERIORATABLE AND BIODEGRADABLE PLASTICS.

THE CHARGE IS TO DEVELOP--AS WE ARGUED EARLIER--FOR APPLYING THE LOGIC INHERENT IN THE ELEMENTS OF THE WASTE MANAGEMENT HIERARCHY--A "SYSTEM" FOR ADDRESSING THE ISSUE. DETERIORATING/DEGRADING PLASTICS ARE BUT ONE COMPONENT OF A SYSTEM COMPRISED OF:

1) REDUCING THE AMOUNT OF UNNEEDED PLASTICS WE PRODUCE,
2) DEVELOPING SYSTEMS FOR RECYCLING PLASTICS ON A SCALE WHICH AT LEAST MATCHES THE RATE FOR ALUMINUM,
3) DETERMINING THE BEST APPLICATIONS FOR DETERIORATABLE/DEGRADABLE PLASTICS, AND
4) BALANCING THE INCINERATION AND LAND DISPOSAL OF THAT WHICH REMAINS IN AN ENVIRONMENTALLY SOUND MANNER.

THUS, THE APPROACH IS LOGICAL AND CONSISTENT WASTE DISPOSAL IS BEST DONE IN A SYSTEMATIC WAY. REMEMBER, RECYCLING IS COMPRISED OF A SYSTEM OF COLLECTION, REMANUFACTURE AND RESALE, AND PLASTICS, AS A COMPONENT OF THAT OVERALL PROCESS SHOULD BE VIEWED SIMILARLY.

INDEED, IF PLASTICS ARE A VALUABLE RESOURCE, AREN'T WE BETTER OFF PURSUING RECYCLABILITY THAN DEGRADABILITY?

COMMENTS ON S 2298

FINALLY, MR. CHAIRMAN, YOU SOUGHT OUR VIEWS ON THE PROPOSED AGRICULTURAL COMMODITY-BASED PLASTICS DEVELOPMENT ACT OF 1988. THE INTENTS OF THE PROPOSED LEGISLATION ARE PROPER AND WELL TARGETTED. THE NEED TO ENCOURAGE THE DEVELOPMENT OF DEGRADABLE PLASTICS THROUGH MARKET STIMULATION ARE LIKELY TO BE HELPFUL IN AN OVERALL WASTE MANAGEMENT STRATEGY AND A PLASTICS SUBSYSTEM AS WELL.

SEVERAL QUESTIONS REMAIN, HOWEVER, FIRST, ARE WE DEVELOPING THE DEGRADABLE PLATSICS WITHOUT CONCERN FOR THEIR BEST ROLE IN THE SYSTEM AND THEIR POTENTIAL IMPACT? FOR EXAMPLE, HIGH DENSITY POLYETHELENE (HDPE) MOST COMMONLY RECOGNIZABLE IN THE ONE GALLON "MILK JUG" CONTAINERS, CAN BE MADE DEGRADABLE. BUT HDPE CAN ALSO BE READILY RECYCLED. WILL THIS, OR OTHER LEGISLATION, RESULT IN DEGRADABLE PLASTICS WHICH ARE LESS RECYCLABLE? IF SO, WILL THE LEGISLATION HELP TO INCREASE THE AMOUNT OF THIS VALUABLE RECYCLABLE COMMODITY GOING TO LANDFILLS OR INCINERATORS. ALTERNATIVES WHICH ARE CLEARLY LESS PREFERRED OPTIONS TO WASTE REDUCTION AND RECYCLING.

SECOND, AT THIS POINT, THE ISSUE OF WHAT REMAINS AFTER THE DEGRADATION OCCURS IS LESS THAN CLEAR. FOR EXAMPLE, IN ILLINOIS A DISTINCTION IS MADE BETWEEN THE CONCEPTS OF BIODETERIORATION AND BIODEGRADATION, AS FOLLOWS. THE FORMER MEANING THE BIOLOGICALLY MEDIATED LOSS OF UTILITY OR PHYSICAL CHARACTERISTICS; WHILE THE LATTER IS DEFINED AS THE CONVERSION OF ALL CONSTITUENTS OF PLASTIC TO CARBON MONOXIDE, INORGANIC SALTS, MICROBIAL CELLULAR COMPONENTS AND MISCELLANEOUS BY-PRODUCTS CHARACTERISTICALLY FORMED FROM THE BREAKDOWN OF NATURAL MATERIALS.

AT ISSUE, ARE THE REMAINS OF THE PROCESS. LITTLE IS KNOWN ABOUT WHAT REMAINS AFTER BIODEGRADATION AND CAUTION SHOULD BE TAKEN BEFORE WHOLE HEARTEDLY PURSUING DETERIORATION OR DEGRADATION AS A PANACEA TO THE PROBLEM OF PLASTICS.

LASTLY, IS THE OVERALL ISSUE OF THE PLACE THE LEGISLATION WILL FILL IN A MOSAIC OF FEDERAL ACTION. BECAUSE OF THE LOCALIZED NATURE OF WASTE DISPOSAL, IT IS DIFFICULT TO PINPOINT PROPER FEDERAL ACTIVITY. A WASTE MINIMIZATION/RECYCLING TASK FORCE HAS BEEN FORMED UNDER THE UMBRELLA OF THE ASSOCIATION OF STATE AND TERRITORIAL SOLID WASTE MANAGEMENT OFFICIALS WHICH WILL LOOK AT THAT ISSUE. LEGISLATION, SUCH AS THIS ENCOURAGING THE USE OF DEGRADABLE MATERIALS, IS IMPORTANT; BUT WHAT OF THE WHOLE MSW DISPOSAL SYSTEM PRACTICE? FOR EXAMPLE, DOES THE NATION NEED WASTE MINIMIZATION LEGISLATION? IN ADDITION, FUNDING ACROSS THE MANAGEMENT SYSTEM IS OF COURSE AN ISSUE TO BE EXPLORED, AS IS THE CAPACITY OF THE FEDERAL GOVERNMENT TO SERVE AS A FOCAL POINT FOR COMPREHENSIVE RESEARCH INTO MINIMIZED SOLID WASTE.

MANY ROLES ARE POSSIBLE; THE FIRST CAUTION WOULD BE THAT PASSAGE OF THIS WOULD APPEAR TO BE A "GOOD DAY'S WORK", BUT ONE DAY WILL NOT PROVIDE THE SOLUTION.

ON BEHALF OF THE STATE OF ILLINOIS, MR. CHAIRMAN, I THANK YOU.

STATEMENT

of

Dr. Roger Lloyd	ICI Biological Products, Wilmington, DE 19897
Mr. Thomas J. Galvin	ICI Americas Inc., Wilmington, DE 19897
Dr. Richard A. Herrett	ICI Americas Inc., Washington, DC 20036

for

ICI

before the

Committee on Goverrment Affairs

United States Senate

on

S.2298 - The Agricultural Commodity-Based Plastics Development Act of 1988

September 20, 1988

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INTRODUCTION

ICI Americas Inc. welcomes this opportunity to present detail on the development of a natural biodegradable plastic to the U.S. Senate's Committee on Governmental Affairs, particularly as it relates to S.2298, the "Agricultural Commodity-Based Plastics Development Act of 1988."

ICI Americas is the U.S. subsidiary of Imperial Chemical Industries PLC (ICI) of London, England, the world's fourth largest chemical company. ICI Americas is based in Wilmington, Delaware, employs more than 19,000 people at nearly 100 sites throughout the United States, and has sales of about $4 billion.

ICI Americas has a broad range of products. Some of the better-known include Glidden paints and Mylanta antacid, but we also manufacture products that serve nearly every major U.S. industry. Our Agrochemicals business manufactures numerous herbicides and pesticides that aid the American farmer. A drug made by our Pharmaceuticals business is the world's leading treatment for hypertension. Each day in the U.S., more than a million-and-a-half hearts depend upon Tenormin. The Glidden company's can coating technology protects the contents of eight out of every ten canned drinks in the United States. Our advanced materials are used by the U.S. Navy in helicopter seats and one of every two cars made in the U.S. use Tribol lubricants, produced by our Specialty Chemicals division.

As you can see, ICI Americas is a company with a broad scope and with a strong commitment to research and development. ICI worldwide spends over $2 million a day on R&D and more than 50% of this in the life sciences - pharmaceuticals, agrochemicals, biological products. One of the products of this research is a group of natural, biodegradable polyesters.

These novel plastics are produced by the fermentation of simple sugars like glucose. Their development is the result of the collaborative research activities of the plastics and biotechnology groups of ICI. This work was initiated in the late 1970's and directed towards the production of novel biological materials from natural feedstocks. It also represented a defensive measure against the threat to the traditional plastics business posed by the sharply escalating oil costs.

The plastics are referred to by the acronym PHBV, which stands for poly (3 hydroxybutyrate - 3 hydroxyvalerate).

The PHBV polymers distinguish themselves by being:

Natural - produced in fermentation by a common soil microoganism and made up of units which occur widely in nature including in the human body.

Renewable - the principal raw material feedstock is sugar derived from such abundant agricultural products as corn, sugar beet or sugar cane.

Truly biodegradable - broken down safely and completely by environmental microorganisms to carbon dioxide and water.

Biocompatible - compatible with human tissue where they may be used in surgical applications and be slowly reabsorbed by the body.

Readily Processed - behave like traditional plastics and may be formed into films, moldings and fibers by conventional technology.

The following describes the development and current status of PHBV commercialization.

HISTORY

It has been known for more than 60 years that many bacteria and algae accumulate the polyester poly (3-hydroxybutyrate) - PHB. The single building block for this homopolymer, hydroxybutyric acid, is a simple fatty acid which occurs widely in nature. The polymer exists as discrete granules within the cell where it is thought to provide a food store for the organism. These microorganisms store polyester much as humans store fat.

In times of excess energy intake, the polymer may account for more than half the dry weight of the cell. However, when needed, it can be very rapidly metabolized and within a few hours 90% of it will be used up by the organism. It is broken down by the cell's own enzymes and metabolized to release the stored energy.

The polyester was first characterized in 1925. It has been shown to be a thermoplastic material often misleadingly compared to polypropylene which has some similar properties. The early potential of the homopolymer PHB was limited by its poor thermal properties and a complex manufacturing process. However, recent advances in the production technology made by ICI have increased organism productivity, improved and simplified product recovery and introduced the range of PHBV copolymers with improved properties and processability.

PRODUCTION

The microorganism selected by ICI for polymer production is the safe, naturally-occurring soil bacterium Alcaligenes eutrophus. This is grown in conventional fermenters on a sugar feedstock, usually glucose derived from corn or wheat starch. Molasses or other sugar rich streams from the corn, sugar beet or cane processing industries may also be used. The plastic is therefore derived from agricultural feedstocks, not from oil.

By controlling the culture conditions, the bacterium can now be made to accumulate up to 80% of its dry weight as polymer. These "fattened" cells are harvested, and the water insoluble polymer is released by rupturing the cell wall. It is separated from the cell mass, filtered and dried in what is now a much simplified and lower cost process. It is then sold either as a powder or resin chip and, from this point, is handled like a traditional plastic.

The discovery that the composition of the polymer could be influenced through the nutrition of the organism during fermentation provided a real breakthrough. The bacterium can be made to incorporate hydroxyvalerate, another widely occuring, natural fatty acid, to provide the novel family of random PHBV copolymers; i.e., polymers made up of the two fatty acid building blocks in random sequence. The amount of valerate incorporation can be controlled and the properties of the copolymers will vary with the varying valerate content.

PROPERTIES AND PROCESSING

PHB homopolymer is a stiff and somewhat brittle material which melts at 350°F, but, unfortunately, decomposes at slightly higher temperatures. The introduction of valerate leads to a reduction in melting point such that a copolymer containing 25% valerate melts at 280°F whilst the decomposition temperature remains roughly the same. PHBV is also a much more ductile, flexible material with improved processability allowing much wider applications for the plastic.

Further work remains to be done to improve the polymer harvesting process and to categorize fully the properties of the plastic and its optimum processing conditions. To date, however, we know it will lend itself to current manufacturing practices. For example, PHBV can be melt or solution processed. Successful extrusion and injection blow moldings have been achieved with standard machines. Foamed moldings may be obtained using nitrogen or chemical blowing agents. Strong oriented single or multifilament PHBV fibre has been obtained by conventional spin-draw techniques and the material can be formed into a cotton wool-like floss or non-woven fabric. Thick and thin films are made by standard film making processes. A tough biaxially oriented film has now been produced and thin films can be laminated on to paper or card.

However, the key properties which distinguish PHBV from traditional synthetic plastics are its biocompatibility and biodegradability.

BIODEGRADATION

PHBV is completely and safely biodegradable. When an article made from the polymer is placed in soil, the natural microorganism population recognizes it as food. Fungi in particular colonize the surface and secrete enzymes which digest the polymer. The products of this digestion are absorbed and metabolized yielding carbon dioxide and water. None of the products of this degradation process offer any toxic or ecological hazard. PHBV, therefore, recycles completely and safely back into nature. As the glucose which provided the original feedstock for the production of PHBV is synthesized by plants from carbon dioxide and water, this represents in theory a closed cycle with sunlight being the prime energy source. PHBV in effect recycles back into nature and offers a truly renewable plastic.

Being a natural process, biodegradation is enhanced by environmental factors - the level of microbial activity, moisture, temperature - and it is

influenced by chemical and physical factors - particularly surface area and surface texture.
An article made from or incorporating PHBV will be totally stable in air. It is not photodegradable. It is only when the PHBV article is placed in an environment of high microbial activity, like soil, sewage or the sea bed, that biodegradation occurs. The higher the intensity of microbial activity, the more rapid the degradation. Anaerobic sewage and river estuary sediments provide faster breakdown than soil or aerobic sewage and, as it is a surface phenomenon, the greater the surface area exposed to microbial attack, the faster the breakdown. A roughened surface will provide more rapid microbial colonization and also speed up the process.

To give an indication of the rate of degradation, a PHBV film placed in garden soil will lose three quarters of its carbon as carbon dioxide within six months. A thin film would disintegrate in a few days in sewage treatment plant whilst a typical PHBV bottle in an active landfill could be expected to disintegrate within a year. PHBV articles which find their way into waterways will tend to sink, as the polymer is denser than water, and will then degrade in the bottom sediment.

CURRENT STATUS

To exploit the potential of PHBV, ICI set up a subsidiary company named Marlborough Biopolymers Ltd. (MBL) in 1983. MBL is a small entrepreneurial organization which participates in a number of collaborations to develop commercial applications for the polymer. The activity is determinedly market led, with MBL working through ICI Americas in Wilmington, Delaware with its potential customers the U.S. to customize polymer processing and formulations to individual application needs.

Production and sale of PHBV have grown with demand. Material is currently produced in Billingham, England at a rate equivalent to 100's of tonnes per annum. We are confident that the production technology is robust and capable of being expanded to full industrial scale. However, it is emphasized that the project is still in the developmental stage and the rate of progress towards full commercialization will be greatly influenced by the rapidly changing legislative, commercial and consumer attitudes to the role of biodegradability in responsible plastic disposal.

Because of the low production volume, the product is still highly priced at $15/pound. However, the target price for technical grade material from a full scale plant is around $2/pound. This is still more expensive than bulk commodity polymers which indicates that the material will first search out niche markets as a specialty polymer and those applications where control of plastic disposal and pollution demands a biodegradable system. It will also encourage the combination of PHBV with other materials, for example paper and other plastics, to extend the volume and reduce costs whilst retaining the important properties of thermoplasticity and biodegradability. One point to remember, however, is that this material comes essentially from the agriculture sector and is unhinged from the supply or price of oil. If oil prices increase again relative to sugar prices or should PHBV be produced in those parts of the world where carbohydrates are abundant and oil imported, then the differential between this natural polymer and petro polymers will narrow.

CONCLUSION

The development of PHBV polymers therefore offers new, natural materials which have many of the properties of traditional oil-derived plastics, but which are made from renewable agricultural feedstocks and are environmentally benign, being safely and completely biodegradable.

The current focus of PHBV activity is in the development and optimization of polymer formulations, processing conditions and applications both as a specialty polymer in the biomedical area and in the disposables and packaging sectors. More work is needed to investigate the technical and economic viability of using PHBV in what might be referred to as commodity plastic applications. Even though current extrusion and blow molding technologies can be utilized, the polymer cannot simply be dropped into production in the many and diverse applications requiring disposable plastics. This is not unlike the history of other plastic polymers the development and commercialization of which stretched over many decades and cost millions of dollars. PHBV's progression to its current status has been relatively rapid, by comparison. However, as noted, more work has yet to be done in cost reduction, polymer characterization, applications development and in our understanding of the role of biodegradable products in the changing world of plastic waste management.

Biodegradable plastic offers one option in what will most likely be a "systems approach" to dealing with the plastic disposal problem. This means that all technologies of source reduction, recycling, reuse, incineration and degradables will be applied. The technology of choice will depend not only upon legal, technical and economic considerations, but also upon the specific application and geographic location.

The PHBV development is responding to this rapidly changing situation and the likely time frame for commercialization of the plastic is 2 to 5 years.

SLIDE 1

PHBV™
BIODEGRADABLE POLYESTERS

Bacterial Copolymers

Thermoplastic Aliphatic Polyesters

Natural

Biocompatible

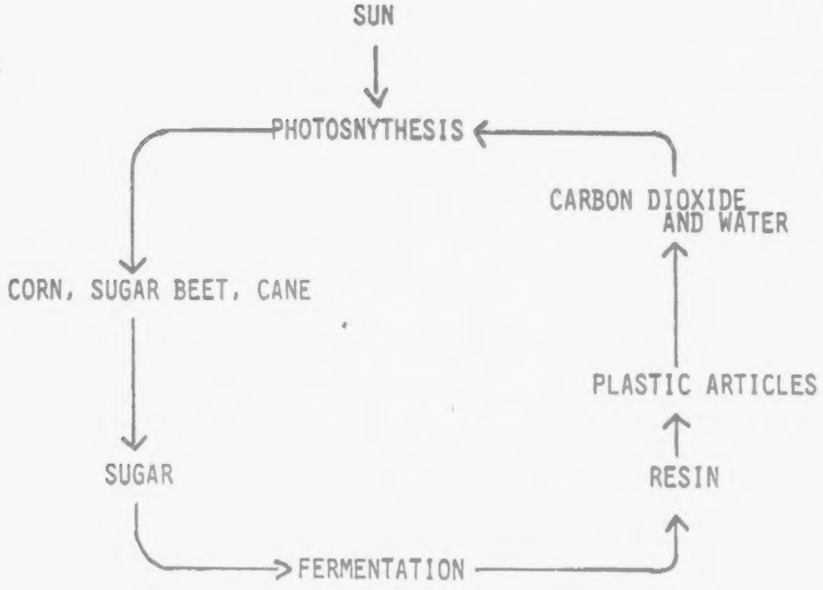
Biodegradable

Renewable

SLIDE 2

PHBV BIODEGRADABLE POLYESTER

DEGRADATION CYCLE



SUN

PHOTOSNYTHESIS

CARBON DIOXIDE AND WATER

CORN, SUGAR BEET, CANE

PLASTIC ARTICLES

SUGAR

RESIN

FERMENTATION

SLIDE 3

PHBV HISTORY

1920's	Discovery of PHB bacterial polyester
1960's	Grace USA worked on PHB production and processing
1976	ICI Plastics and ICI Agricultural Divisions initiate PHB program
1983	Marlborough Biopolymers Ltd. (MBL) formed PHBV copolymers developed
1984	U.S. copolymer patent granted
1985	First melt processing of films
1986	First blow molding of bottles
1987	Production scaled-up

SLIDE 4

PHBV CURRENT STATUS

Development
- Internal
  - Bioproducts
  - Films
  - Polymer Additives
  - ICI Australia
- External
  - Corporate Agreements
  - Universities

Production
- ICI Bioproducts
- External Contracts
- 200 M^3 Fermenters — 100 tonnes/year
- Range of PHBV polymers on inventory

Price
- $15/pound delivered USA

SLIDE 5

PHBV IN NORTH AMERICA

Issues

- Markets
- Legislation
- Technical
- Timing

THE SOLID WASTE PROBLEM

- Marine Pollution
  - Ship Dumping
  - Illicit Sewage and Trash Dumping
  - Tampon Applicators, Hygiene Products
  - Litter and Wildlife Hazard
- Solid Litter
  - Six Pack Loops
  - Fast Food Containers
  - Horticultural Wastes
- Landfill Crisis
  - Disposal Sites Disappearing
  - Disposal Costs Escalating
- Public Opinion
  - Environmental Concerns
  - Increased Cost and Complexity of Trash Collection

SLIDE 7

THE SOLID WASTE SOLUTION: A TOTAL SYSTEM APPROACH

Recycling
- PET, HDPE, commingled plastics
- Problems with collection, end use
- 50 companies active

Incineration
- technology available; energy recovered
- huge capital costs
- public resistance — "NIMBY"

Landfill
- technology available
- biodegradable
- compostable
- methane recovery
- public resistance — "NIMBY"

Litter
- photodegradable

Thomas G. Byrer, Senior Vice President for Advanced Materials, Battelle Columbus Division

My name is Thomas G. Byrer, and I am Senior Vice President for Advanced Materials at the Columbus Division of Battelle Memorial Institute, Columbus, Ohio.

I have been requested to present some observations about state-of-the-art technology in the biodegradable packaging thermoplastics area, as well as a perspective on what is achievable in the future for this key technology. We appreciate the opportunity to testify on these important subjects.

State-of-the-Art Technology

There are good reasons for the use of plastics for packaging. Plastic packages are attractive and can be fabricated and filled quickly with specific units of products. These packages maintain product cleanliness and storage stability, and have other desirable qualities such as transparency for inspection of contents. Such packages also are known for their low cost of production and chemical stability. This stability, however, leads to very long life of the plastic so that when its one-time use is completed, discarded packages remain in the environment for very long times.

Nearly 13 billion pounds of plastic packaging materials were sold in the U. S. in 1987.(1) Table 1, which is attached to my testimony, shows sales of several major plastic packaging materials, and Table 2 presents sales by end use. A significant amount of this plastic is discarded and creates the plastic pollution that others will describe in great detail at this hearing.

Several actions can be undertaken in the near-term to help alleviate the problems of plastic pollution. These actions can be implemented soon because they do not involve substitution of new materials for established ones. Examples of these actions include:

- Recycling and/or re-use of plastics to reduce the burdens on the disposal systems.
- Re-education of consumers and others regarding disposal practices for plastics use systems.
- Re-design of plastics packages to reduce hazards to wildlife and to facilitate disposal via landfill and incineration routes.

A longer term solution will come from development of degradable plastic packaging materials. Several early examples of such materials are shown in Table 3 of my testimony.(2) The photodegradable resins contain ultra-violet sensitive materials and thus will disintegrate in the presence of sunlight - not truly biodegradable. In a landfill disposal, they are not degraded since there is no exposure to sunlight.

St. Lawrence Starch Co. and other companies have blended and grafted starch into polyethylene. The starch, at approximately 5 percent by weight, is biodegradable, permitting the package item to disintegrate after the starch is removed by microorganisms. The fate of the remaining plastic is not known, but is probably not degraded in any reasonable time nor are the degradation products known to be harmless.

ICI of the United Kingdom is presently at the pilot plant stage with their product. These are truly biodegradable, selling for $15/lb. ICI hopes that the price can be reduced to $2/lb with further scale-up.

The polymers and copolymers of lactic acid are biodegradable. These polymers are easily processed in contrast to the previously mentioned products. Polymers of lactic acid are truly biodegradable via hydrolysis over a time period of several months to a year. In a wet environment, they begin to show degradation after several weeks and may disappear in about a year's time when left on or in the soil or seawater. The normal biodegradation products are lactic acid plus carbon dioxide, methane, and water--all of which are present in the environment.

Lactic acid is potentially available from inexpensive feedstocks such as cornstarch or corn syrup by fermentation. In practice, lactic acid is converted to lactide and then conveniently converted to resin by catalyzed, melt polymerization,(3) a general process well known to plastics producers. Molecular weight can be easily controlled. Compositions can be varied to introduce specific properties such as stiffness, toughness, or pliability, and have been suggested as replacements for conventional petrochemical-derived plastics.(4,5,6)

In principle, commodity scale production of polylactic acid packaging materials would derive from a sequence of processes shown in Figure 1 of my testimony These processes or technologies are all well known except for the lactic acid purification step (from fermentation), the compositions needed for replacements of materials in specific applications, and the tailoring of resins for melt processing.

Proprietary research on this subject at Battelle has shown preliminary feasibility. This research could lead to semi-works production in approximately 2-1/2 years. These lactic acid polymers are superior, in our opinion, to other degradable materials because of the following:

(1) They are fully biodegradable.

(2) They are easily processed-recyclable thermoplastics.

(3) They can provide a close match to performance characteristics of existing nondegradable plastics (e.g., polyethylene, polystyrene).

(4) They can be low priced and should compete price-wise (with polystyrene and polyethylene) at commodity scale.

In addition, they can be based entirely on corn or other sources of fermentable sugars as feedstocks.

What is Feasible?

Use of plastics that degrade by biological, photochemical, and possibly other mechanisms represent an important part of the solution to our total pollution problem.

The current versions of degradable plastics described in Table 3 can be considered pioneers and prototypes. Although they may not win large markets, they are providing the initial data that will lead to improved versions that may have significant use later.

Application of more sophisticated design of composite materials could improve performance significantly. Preprints of papers to be presented by the USDA and by Purdue at the next meeting of the American Chemical Society illustrate this approach. For example, the initial attempts to combine starch with polyethylene involved simple blending and now the emphasis is on engineering large contact areas between the two components.

The development of biodegradable thermoplastics, such as our lactic acid copolymers, also will evolve rapidly. Although these polymers are unique now, we can expect that several families of such polymers will be developed because of the advanced state of polymer science and technology. Competition will focus on the ability to continue using the same package fabrication ("conversion") systems as are used now while providing consumer satisfaction, shelf life, and environmental degradation.

Reactive processing is a growing technology that will prove to be relevant to future biodegradable products, in our opinion. There also are opportunities for materials that degrade because of constituents that are built into the products so that they do not need any trigger other than completion of use by the consumer.

The present system has considerable momentum and we expect the changes to be on a product-by-product basis. The timing of the introduction of new degradable packaging products will depend on how motivated the developers are and the speed at which the technology develops. A major new product can require six years to make a significant impact, even if its bench-scale research data looks very promising. Now it is clearly time to start introducing new products and getting the reaction of both the consumers and the environment to the new materials.

The glamorous side of research on degradable materials is the materials development side. However, what is "doable" will also be determined by state-of-the-art in the evaluation methods that confirm degradation of the material to safe products and the estimated time for the degradation to occur. Accelerated testing methods would allow all of the research to be done more quickly. We also need to observe and understand what happens in various environments: seawater, landfills (dry and wet), surface litter in dry areas and in wet areas. This includes the fate of packaging materials and their effects on the environment. The more that we know about fate and effects, the better we can put technology to work to solve these problems.

In summary, the plastics pollution problem can be addressed in several ways:

(1) Pursuit of recycling methods and technology that are economically attractive

(2) Enhanced education of the general public concerning the true effects of plastics pollution on our environment

(3) Design of total packaging systems that include recycling and disposal considerations

(4) Accelerated research on new plastic materials that represent viable products for our U. S. plastics industry in meeting the demands of the marketplace and the critical concerns for cleaning up our environment.

Thank you for the opportunity to provide these observations. I will be pleased to answer any questions.

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(1) Modern Plastics, Jan., 1988, p. 95.

(2) Modern Plastics, August 29, 1986, p. 84.

(3) R. G. Sinclair, SPE, 45th Annual Technical Conference (ANTEC), p. 1215, 1987.

(4) R. G. Sinclair, U. S. Patent 4,045,418 (to Gulf Oil Corp.), Aug. 30, 1977.

(5) R. G. Sinclair, U. S. Patent 4,057,537 (to Gulf Oil Corp.), Nov. 8, 1977.

(6) Materials Engineering, p. 63, Sept., 1981.

TABLE 1. VOLUME OF MAJOR ONE-WAY PLASTICS(1)

Material	Million, lb 1986	Million, lb 1987	Percent Growth	Major Uses
Polyethylene (PE)	6076	6694	10.2	Container, Coatings, Film
Polystyrene (PS)	1247	1346	7.9	Molded Closures, Foams, Sheet
Polypropylene (PP)	1117	1263	13.0	Closures, Films, Straws
Polyvinyl Chloride (PVC)	594	611	2.9	Film, Containers

TABLE 2. RECENT USE PATTERNS FOR ONE WAY PLASTICS(1)

Use	Million, lb 1986	Million, lb 1987	Major Material
Closure	624	676	PE, PS
Coatings	1,018	1,114	PE
Containers	5,785	6,433	PE, PS
Film	4,050	4,426	PE, PP, PVC
Trash Bags	1,184	1,215	PE
Diaper Backing	148	177	PE
GRAND TOTAL	12,809	14,041	

TABLE 3. DEGRADABLE PLASTICS(2)

Source	Product Information	Degradation Type	Current/Potential Use	Technology
Ecoplastics, Willowdale, Ont.	Ecolyte masterbatch	Photodegradable ketone copolymer	Used in mulch film, with potential in bags as well.	Molecules are altered by interspersing ketone carbonyl groups on polymer chains during synthesis.
Dow Chemical Six-pack, Midland, MI DuPont Co. Wilmington, DE Union Carbide Danbury, CT	Resin	Photodegradable ethylene/carbon monoxide comonomer	Current use exclusively in 11 states requiring degradable six-pack yokes. Dow has applied for FDA approval	Incorporates carbonyl groups by copolymerizing ethylene and carbon monoxide so that UV absorbing carbonyls snap to weaken chain.
Ampacet, Mt. Vernon, NY	Poly-grade masterbatch	Photodegradable additive system	Used in Bespac trash bags made by Webster Industries.	A proprietary additive susceptible to UV after absorption degrades low-density PE.
Princeton Polymer Labs Princeton, NJ	Additive system for licensing	Photodegradable additive system	No current commercial use. Suited for use in polyolefins and PS	Combines a photoactivator and prooxidant synergistically to break polymer chains.
Ideamasters, Miami, FL	Plastigone proprietary resin	Photodegradable additive system	Used in Israel in mulch film. Wider uses expected	Additives absorb UV, releasing metal ions in antioxidant to act as catalysts in breakdown of chains.

TABLE 3. DEGRADABLE PLASTICS (Continued)

Source	Product Information	Degradation Type	Current/Potential Use	Technology
ICI Americas, Wilmington, DE	Biopol resin	Biodegradable aliphatic polyester copolymer	Production of bottles in Europe was planned for late 1987.	PHB polyesters are produced by soil bacteria during fermentation of sugars to produce a natural polymer.
U. S. Dept. of Agriculture, Washington, DC	Technology available for licensing	Biodegradable starch additive	Agri-Tech Industries, Gibson City, IL plans plant for brown film.	Starch is used to fill ethylene-acrylic acid or EAA film, after which microorganisms attack the natural polymer causing film to degrade.
St. Lawrence Starch, Mississauga, Ontario	Ecostar masterbatch	Biodegradable starch additive	Used in trash bags and bottles	Starch is silane treated for compatibility with polymer; when consumed by fungi the starch leaves porous structures that disintegrate.

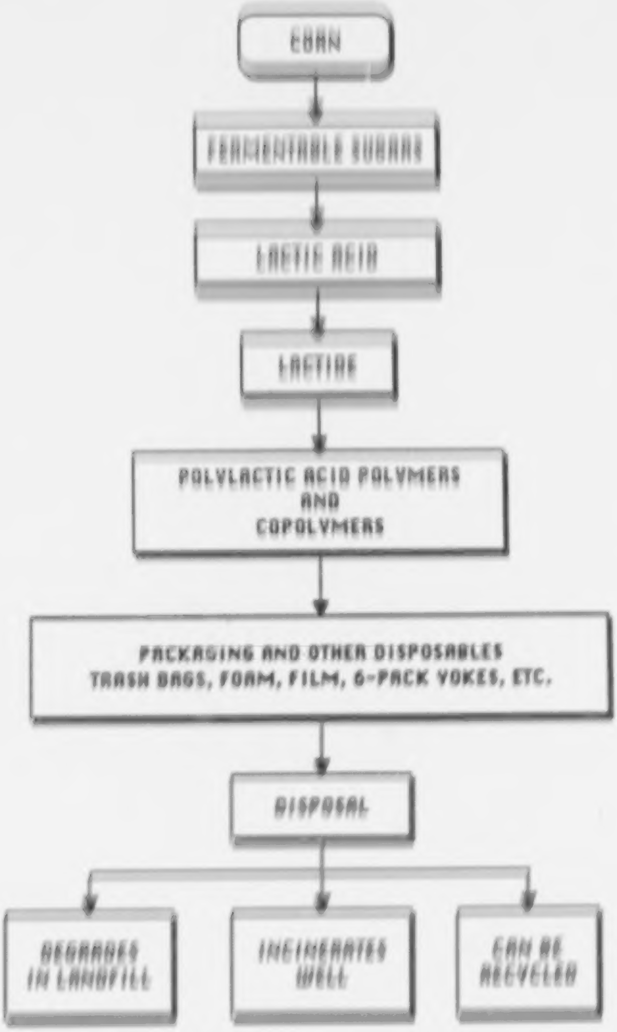
CORN
FERMENTABLE SUGARS
LACTIC ACID
LACTIDE
POLYLACTIC ACID POLYMERS AND COPOLYMERS
PACKAGING AND OTHER DISPOSABLES TRASH BAGS, FOAM, FILM, 6-PACK YOKES, ETC.
DISPOSAL
DEGRADES IN LANDFILL
INCINERATES WELL
CAN BE RECYCLED

FIGURE 1. ROUTES TO BIODEGRADABLE PLASTICS VIA LACTIC ACID

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Statement

of

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Quantum Chemical Corporation
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for

The Society of the Plastics Industry, Inc.

before

The Committee on Governmental Affairs

United States Senate

September 20, 1988

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I am Peter P. Hanik, Director of Applied Research and Technical Services, Quantum Chemical Corporation, USI Division, based in Rolling Meadows, Illinois. I am pleased to present the views of The Society of the Plastics Industry, Inc. (SPI). SPI appreciates the invitation of Senator Glenn, Chairman of the Senate Committee on Governmental Affairs, to discuss the content and objectives of S 2298, the "Agricultural Commodity-Based Plastics Development Act of 1988." Senator Glenn, in your letter of invitation to SPI, you stated that you are particularly interested in SPI's perspective on the problems related to solid waste management and potential solutions that exist. SPI invited me to speak for the industry on S 2298 because my company is currently evaluating some plastic products modified with the corn-starch containing additives this bill would subsidize.

SPI is a trade organization of more than 2,000 members representing all segments of the plastics industry in the United States. SPI's operating units and committees are composed of resin manufacturers, distributors, machinery manufacturers, plastics processors, moldmakers, and other industry-related companies and individuals. Founded in 1937 SPI serves as the "voice" of the plastics industry.

SPI supports the goals outlined in S 2298 to help restore the economic vitality of the nation's agricultural industry and to help solve the growing solid waste disposal problem. SPI is concerned, however, that the proposal is based on the presumption that the widespread use of the commercially-available, agricultural commodity-containing plastics, per se, represents a viable solution to this growing disposal problem. As I will later detail in this testimony, we have serious reservations concerning the validity of this presumption. Recycling is supported by this and other industries, as well as by governmental officials at all levels, as a significant technology for solid waste management; the effects of degradables on recycling are not yet known. Also, widespread degradation of plastics would eliminate the potential for recovery of their very high energy or Btu value (equivalent to oil). In addition, we believe that the potential impact of the use of the modified plastics on the economic health of the agricultural community is greatly overstated, and the bill, if enacted, would create unachievable expectations.

OVERVIEW OF PLASTICS

Introduction

To understand SPI's views on degradable plastics, SPI believes it would be helpful to the committee to review not only the history and current status of the development of plastics with enhanced degradability, but also where plastics are used, and, more importantly, which plastics are used, and why. Plastic materials have been chosen by the marketplace because of their specific and, in some cases, unique mechanical and physiochemical properties, overall design and performance characteristics, and economics. An additional requirement or expectation such as degradability enhancement should not be suggested without considering the impact it would have on the other properties which lead to the choice of a plastic material in the first place.

Plastics is a generic term for a group of materials as is the term "metals." Plastics can be as different from one another as is iron and aluminum or lead and gold. Some plastics are transparent, some are translucent, some are flexible, some are rigid. All are lightweight and resistant to microbial attack. In addition, scientists have learned to control the synthesis of each type of plastic and thus, within limits, tailor-make plastics materials with properties best suited to the variety of applications for these materials.

Plastics Use and Packaging Applications

In 1987, approximately 70 percent of the 50 billion pounds of plastics sold in the United States were fabricated into long-life applications in transporation, construction, furnishings, health care, electronics and other applications. Some of these long-life applications are potential markets for recycled plastics. The remaining 30 percent were utilized in packaging and other short-life uses. Ten percent of this was used as a coating on other materials, particularly paper. The plastics resins used in packaging primarily consist of low density polyethylene (LDPE) and linear low density polyethylene (LLDPE) (40%), high density polyethylene (HDPE) (28%), polypropylene (PP) (10%), polystyrene (PS) (9%), polyethylene terephthalate (PET) (7%), and polyvinylchloride (PVC) (4%). By application, the principal uses in industrial, institutional and consumer packaging were: flexible packaging, including bags, liners and film (40%); bottles, jars and vials (20%); containers (17%); and all others 24%.

Films used for wrapping and laminating and for making bags are made from all six of the above-mentioned packaging plastics. In most cases, the choice of plastic used for a particular packaging application is dictated by the application requirements. For example, PVC is used for bloodbags because of its outstanding oxygen barrier properities and compatibility with contents. PET is used in "boil in the bag" pouches because of its barrier properties and higher melting temperature requirement. In some cases the combination of mechanical properties and overall product economics are the major determinants. For example, the change from low density polyethylene to linear low density polyethylene has reduced the thickness of polyethylene garbage bags by 20% while retaining equivalent strength. Further, the LLDPE or high density polyethylene grocery sack represents a savings of 60% by weight over the paper grocery bag with equivalent capacity, and occupy 1/6 of the volume of their paper counterpart.

Plastic bottles and containers also are made from the same six plastics. Plastics have become the preferred material for a number of reasons, a principal one being safety. Plastic bottles rarely break when dropped by the consumer or on the plant filling line. Plastic bottles are typically eight to ten times lighter than their glass counterparts which makes them easier to handle and markedly reduces transportation and energy costs. Again, the choice of plastic used is dictated by the application. Polyethylene (PE) is most commonly used because of its toughness, moisture barrier properties, inertness and low cost, and when transparency is not required. Commonplace examples of polyethylene packaging are milk jugs, household chemicals and margarine tubs. The plastic soft drink bottle is made from PET which retains the carbonation. Some cooking oil bottles are packaged in PVC to take advantage of the clarity and oxygen impermeability of this material. Tough polyethylene pails, carboys and drums have replaced steel containers for various liquid products, from food to building products, because of their corrosion resistance and excellent strength-to-weight ratio.

As I noted previously plastics are used in packaging applications as a coating on other materials, particularly paper. To provide protection from package deterioration and to maintain product and shelf-life, paper or metal foil packaging are often coated with plastic where there is contact with moisture, grease, oils or chemicals. In food packaging applications, the plastic is the interior food contact surface because of its inertness (or resistance to microbial attack) and compatibility with food stuffs.

In summary plastics products have been chosen by the marketplace because of their specific, and in some cases unique, mechanical and physiochemical properties, overall design flexibility, performance characteristics, and economics. In the majority of applications durability of plastics is an essential characteristic. In many other applications chemical or moisture resistance, or gas barrier properties, are necessary.

DEGRADABLE PLASTICS TECHNOLOGIES

It also is useful to review the technologies used to make certain plastics more degradable. In the late 1960s and early 1970s a good deal of research was directed towards developing plastics with enhanced degradability. These research efforts followed either of two paths; one was to increase the susceptibility to degradation by ultraviolet (UV) light; the other was to incorporate biodegradable additives into the plastic with or without additional chemical degradants. (Most plastics are susceptible to degradation when exposed to the ultraviolet light rays of the sun, albeit at a very slow rate; most are resistant to microbial attack.)

Photodegradation

Several techniques for increasing the UV susceptibility of plastics, particularly polyethylene, have been developed. One method specific to low density polyethylene is to use carbon monoxide as a comonomer with ethylene during polymer synthesis, thereby, introducing the UV sensitive carbonyl group directly into the polymer chains. This technology is used to manufacture the plastic used to make photodegradable ring carriers. The technology has been commercially applied to low density polyethylene.

Another method to introduce UV sensitive (also known as photosensitive) carbonyl groups into the basic plastic resin is to use a vinyl ketone as a comonomer. This technique reportedly has been used to manufacture polyethylene, polypropylene and polystyrene copolymer concentrates which can be blended into plastic of the same type at the 5 percent to 10 percent level, thereby making the blend degradable upon exposure to ultraviolet light.

A third approach is the incorporation of photosensitive oxidizing additives into the plastic which "activate" upon exposure to ultraviolet light and degrade the plastic. This approach has reportedly been applied primarily to film-grade polyethylene plastic used in agricultural applications as temporary groundcover.

Biodegradation

Research on incorporating biodegradable additives into plastics has focused on the use of cornstarch as the biodegradable component. Two approaches have been pursued. One method, developed by the U.S. Department of Agriculture, is to incorporate 40 percent to 60 percent gelantinized starch in a blend of neutralized ethylene/acrylic acid copolymer and low density polyethylene. Additional low density polyethylene may be blended into the mixture to improve mechanical properties while decreasing the degree of degradability. This approach has been used to extrude blown film on an experimental, laboratory scale.

Another approach, also developed in the mid-1970's, is to blend starch, treated with a coupling agent to improve compatibility, and a small amount of an auto-oxidant such as corn oil, into the plastic resin. The manufacturers of the starch-containing additives recommend a starch loading of 5 to 15 percent in the finished item, depending on the application. The starch reportedly is consumed by microorganisms upon soil contact. The corn oil reacts with oxygen, catalyzed by metal salts in the soil or added to the plastic, forming peroxides which further degrade the weakened porous plastic, ultimately rendering it susceptible to biodegradation. To date, these additives have been evaluated primarily in polyethylene-based film products.

The impact of incorporating those starch-based additives into plastics on the mechanical and physiochemical properties of the resulting material is, at best, little understood. Initial laboratory investigations by my company are, to date, not encouraging; nor are data made public by one of our competitors. To illustrate, in linear law density polyethylene grocery sack applications, a gauge (thickness) increase is required to obtain equivalent strength at a starch loading of 6 percent, leading to an estimated 10 percent increase in plastic consumption. Further, it is reported that firm making equipment must be operated at lower temperatures to prevent charring of the starch. This leads to decreased equipment productivity and increased electrical consumption. Ignoring the cost of the starch-based additives, these additional cost penalties are estimated to add 15 percent, minimum, to the manufacturing cost of these items.

A novel biodegradable plastic is the poly (hydroxybutyrate-valerate) copolymer. This copolymer is a fermentation product of a soil microorganism grown on a mixed sugar and fatty acid feedstock. A companion product, polyhydroxybutyrate homopolymer, has been investigated by many researchers over the years since first being characterized in 1925. Poor production processes, very poor temperature stability and generally poor mechanical properties of the homopolymer hindered market development. However, recent advances in fermentation techniques and product recovery technology led to the patenting and market entry of the copolymer in the early 1980s. Although commercially available in small quantities, the copolymer is extremely expensive relative to commodity thermoplastics and is definitely in the developmental stage of commercialization.

In June 1987, SPI sponsored a technical Symposium on Degradable Plastics at which papers discussing all of the above-mentioned technologies were presented. SPI has recently issued a call for updates to its symposium proceedings but no new technology has yet been reported.

At the National Plastics Exposition in Chicago in June, a triannual trade show for the plastics industry sponsored by SPI, several companies promoted their proprietary versions of degradation enhancing plastic additives. In a novel development one company is promoting a unique additive package which combines a photosensitive additive and starch/auto-oxidant additive for use in polyethylene films. Another company, which is marketing the vinyl ketone copolymer concentrate, is currently seeking a "non-additive" clearance from the U.S. Food and Drug Administration for use in food contact applications.

In another development, it has recently been reported in the trade press that a major U.S. polyethylene resin producer has completed a production plant trial of blow molded plastic bottles utilizing a starch modified polyethylene resin. Lengthy (and costly) product performance trials are being conducted to determine the acceptability of the product.

CONTRIBUTION TO AGRICULTURAL ECONOMIC HEALTH

It appears that a significant rationale for support of S 2298 is that it could help provide a significant economic benefit to the agricultural community. We understand that some have estimated that "cornstarch-based plastics could replace 30 to 45 percent of the low-density polyethylene plastics used each year, producing an additional market for approximately 112 million bushels of corn per year." We believe that this number represents a gross over-estimate of the potential use of cornstarch in biodegradable plastics. Following is SPI's attempt to help clarify the underlying economic premise with an estimate of the amount of corn that could conceivably be used.

First, since approximately 70 percent of plastics are used in durable applications, these markets must be served by environmentally persistant materials, and not starch encapculated plastics or any other degradable plastics technology. The remaining approximately 30 percent of the plastics are used largely in packaging applications. At this time, no plastic products with enhanced degradability have been shown to meet the Food and Drug Administration (FDA) requirements for direct contact with food. While it is possible that certain photodegradability technologies may be cleared for direct food contact, it is premature to assume that plastics with enhanced biodegradability will be acceptable for direct food contact. In addition, the effect of starch-based additives on the gas and moisture barrier properties of plastics packaging is unknown. In many applications, both food contact and non-food contact, good barrier properties are essential.

Currently, the cornstarch containing plastics being manufactured or evaluated utilize between 5-15 percent cornstarch, although typically this is about 6 percent. If, for example, 10 percent of the total 50 billion pounds of plastics produced domestically in 1987 (representing approximately half of the non-food contact, non-durable plastic consumption) was manufactured with 10 percent cornstarch (500 million pounds of cornstarch), approximately 12.5 million bushels of corn, or 0.17 percent of the average domestic production in the period 1981-85 would be consumed annually. Frankly, we do not know if cornstarch incorporation is technically feasible in all of the applications represented by this example calculation. Thus, we believe our calculation represents an optimistic estimate of cornstarch consumption in plastics manufacturing, without any regard to economics. Therefore, it appears doubtful that this bill could provide a significant economic benefit to the agricultural community.

We believe it is likely that virtually all plastic products manufactured with cornstarch additives would have manufacturing costs above those of the non-starch-containing counterparts, just because of the increased plastic resin required to achieve "equivalent" mechanical properties.

PLASTICS WITH ENHANCED BIODEGRADABILITY - A SOLID WASTE SOLUTION?

Plastics with enhanced biodegradability may play a role in reducing the lifetime of plastic items which are littered. However, the potential impact of these materials on the solid waste management of the remaining plastics waste stream is less clear. Scientists studying landfills have shown that all solid wastes, even materials regarded as readily biodegradable, degrade very slowly in sanitary landfills. To illustrate, in ten year old simulated sanitary landfills food and yard wastes exhibit little or no signs of degradation. Newsprint in 20-plus year old sanitary landfills is readily readable. As a result, "biodegradable" solid wastes have no significant effect on the conservation of landfill space during the life-span of these disposal facilities.

While I have just stated that research on landfills indicates that there is very little overall biodegradation of materials in landfills, other studies have shown that where degradation does take place, this decomposition by bacteria generates methane gas (considered to be a greenhouse gas), an increasingly recognized safety problem. There is also the question of the impact of biodegradation by-products on leachate that may affect groundwater. Since the majority of our nation's landfills are not equipped with landfill gas vents or collection systems, nor leachate collection systems, degradation in landfills can result in environmental and safety hazards. Without emission and effluent controls it is our view that landfills are better suited to the disposal of environmentally persistant solid waste, such as glass, non-hazardous metals, ceramics, concrete, plastics, etc. Landfilling degradation-resistant materials seem to be an environmentally sound approach to solid waste management.

RELATIONSHIP OF BIODEGRADABLE PLASTICS TO RECYCLING

SPI believes that before federal endorsement and subsidization of biodegradable plastics is seriously considered, there should be a clear understanding of the effect of plastics with enhanced degradability technology on plastics recyclability and recycling. Some in our industry who are in the process of evaluating the cornstarch additive technology are convinced that it is detrimental to the recycling of plastics since the durability and strength of the plastics is adversely impacted. Widespread use of starch encapsulation would appear to be counter productive at this time, if recycling is to be a part of our nation's solid waste management strategy. It is not yet practical to separate degradable plastics in the waste stream from their non-degradable counterparts. In addition, preliminary research indicates that the trim scrap from cornstarch encapsulated polyethylene cannot be recycled in-house. This widespread use would be a tremendous blow to industrial sector recycling. For example, virtually all polyethylene film industrial scrap is recycled in-house.

Because of the widespread interest in the use of degradable plastics as a solid waste technology, and the need to understand its relationship, if any, to solid waste management technologies, it may be more appropriate for Congress to consider this issue in the context of reauthorization of the Resource Conservation and Recovery Act.

PROCUREMENT PREFERENCE FOR AGRICULTURAL COMMODITY-BASED DEGRADABLE PLASTICS

SPI firmly believes that it is premature at this time to establish a procurement preference for any degradable plastics because overall the technologies I have previously mentioned are generally unproven and still under evaluation, but especially with regard to starch-based biodegradable plastics. The bill presumes successful commercial technology and this simply is not the case. It will be appropriate to discuss the merits of the basic concepts in S 2298 when and if that technology is proven in applications and, with regard to the bill's stated goal of addressing the nation's solid waste problem, we know whether degradable plastics contribute a practical and environmentally-sound solution to the problem.

SPI has another concern with regard to the bill's stated preference for a particular degradable technology, that is, it is inappropriate for the federal government to promote a single degradable technology, and with a price preference for that technology as well, at a time when there are a number of degradable technologies undergoing evaluation and research by industry, and when there are so many unanswered questions. I would note that the plastics industry is a highly technologically capable and creative one and it may be that any or all of the various degradable technologies could, with significant additional research, be developed to work effectively in different environments. But that answer is down the road and the presumption that this will occur should not be made at this time.

Further, SPI believes that it would be inequitable and inappropriate for the federal government to provide the bill's stated price preference for agricultural commodity-based biodegradable plastics when in fact many in industry are investing significant amounts of money on research and development on degradable technologies including corn-starch additive based.

The industry is responding rather aggressively to the public's interest in degradable plastics. It is inappropriate for the federal government to pursue such an action when there are important questions regarding whether or not the technology works and, in fact, solves any problems without creating new ones.

WHAT IS BIODEGRADABLE

Currently there is no generally accepted standard for measuring degradability. The American Society for Testing and Materials (ASTM), a major independent, third party standards-making organization, is considering establishing within its committee on plastics, a subcommittee to develop standard methods to evaluate the degradabilty of plastics, in recognition of the lack of generally accepted procedures for determining degradabilty.

The recent Administration-published "Report of the Interagency Task Force on Persistant Marine Debris" devoted an entire chapter to the assessment of degradable plastics technologies. The report also recognized the lack of standards for measuring biodegradation and photodegradation of plastics. The report recommends that the National Institute of Standards and Technology, previously known as the National Bureau of Standards, work with ASTM to develop standards. It should be noted that there are no standards for evaluating the degradability of alternative non-plastics products. If degradabilty is deemed to be a desirable attribute, all products should be evaluated for degradable performance.

The Interagency Task Force Report also identified a number of important unanswered questions about the current state of degradable technology such as the rate of degradation, especially vis-a-vis aesthetic impacts; effects on entanglement hazards; the effect of the marine environment on the degradation process; and the environmental impact of the by-products of degradation. The report recommends that EPA, FDA and the National Oceanic and Atmospheric Administration work with the industry to elucidate these environmental impacts. The committee also should be aware that the Environmental Protection Agency has a Congressionally-mandated study currently underway addressing plastics in the solid waste stream, with a particular emphasis on degradable plastics, their benefits and the associated environmental effects. This report is expected to be provided to Congress by June 1989.

Also, the Congressional Office of Technology Assessment (OTA) is working on a study evaluating how different technologies for reducing and managing solid waste can be used in an environmentally and cost-effective long-term solid waste strategy. We are advised by OTA that their study will attempt to put into perspective the relationship of degradable plastics to the overall solid waste management technologies. We urge this committee to review that report which OTA expects to provide to Congress by the Spring of 1989. Again, it may be appropriate to discuss the advisability of degradable plastics in the context of the RCRA debate and decision-making process.

CONCLUSION

S 2298 has two stated goals: to help restore the economic health of the agricultural industry and to contribute a solution to the nation's growing solid waste disposal problem. SPI's rough calculation suggests that the potential for the use of cornstarch modified plastics has been greatly overstated. The use of the degradable cornstarch technology would be undersirable in 70% of the plastics which are manufactured into durable products where strength and durability are essential, such as in construction materials, electronics and home furnishings. A number of companies in the plastics industry are currently evaluating the various degradable technologies for certain non-durable plastics products applications. Because the amount of cornstarch additive typically used or being tested is in the range of 5 to 15 percent (more requires the use of more plastics resin for the necessary product strength), widespread use of this technology would appear to represent only a small fraction of the corn surplus.

SPI is concerned that the proposal is based on the presumption that the widespread use of the commercially-available agricultural commodity-containing plastics represents a viable solution to this growing disposal problem. SPI thinks that it is very important that there be a clear understanding of the impact, if any, of cornstarch-based biodegradable plastics, as well as of the other degradable technologies, on plastics recyclability and recycling before the federal government promote and subsidize its use. There is a strong national interest in significantly increasing the amount of recycling throughout the United States and, particularly, increasing the amount of plastics recycling. We should know whether these two technologies are in conflict or are compatible before the public policy decisions are made. We do not know this at this time.

Biodegradable plastic may address litter, although it is more certain that photodegradable does. It is not at all clear what role biodegradable plastics should play, if any, in an integrated solid waste management system. Degradation is, in fact, a complex and slow process. Many materials generally regarded as degradable deteriorate either slowly or not at all; for example, studies conducted for EPA indicate that over 60 percent of the materials currently being landfilled are those that are considered to be degradable (paper, yard waste, etc.) yet there is a landfill shortage. In addition to recycling, the recovery of the very high energy value of plastics (equivalent to oil), through resource recovery or waste-to-energy systems, would appear to be a more beneficial solid waste management technique.

It is clear that there is interest in degradable plastic products. SPI is convinced that degradable plastic products will find their niche in satisfying appropriate environmental and marketplace needs. The plastics industry has thrived on product innovation and satisfying marketplace needs. SPI believes, however, that much more product development, performance evaluation, and environmental study should be completed before public policy decisions regarding the procurement preference be made.

I appreicate the opportunity to present SPI's views and will be pleased to answer any questions.

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George A. Makrauer
President and Chief Executive Officer

Amko Plastics Inc.

I appreciate the invitation of Senator Glenn to comment on S.2298, the "Agricultural Commodity-Based Plastics Development Act of 1988". This paper presents responses to your questions along with some of our thoughts.

Amko Plastics Inc. is a manufacturer of polyethylene plastic bags used in non-food retail store sales-counter packaging, consumer and industrial product packaging, institutional medical services, and promotional marketing programs. Amko's manufacturing processes include: 1) the extrusion of high strength, energy efficient polyethylene resins into rolls of thin film; 2) printing the film with customer designs and information using water based inks; 3) injection molding and otherwise fabricating various types of bag handles; and 4) the conversion of the printed rolls and handles into finished bags. Amko sells its products in all 50 U.S. states. (Regretably, export opportunities do not exist.)

BACKGROUND OF AMKO'S DEGRADABLE MATERIALS ACTIVITIES

The philosophy behind S.2298 is the stimulation of new research and the development of advanced plastics technologies using agricultural products. This commitment to research and development coincides with the spirit of innovation that has characterized Amko Plastics. Throughout its 22 year history, Amko has successfully initiated many new manufacturing and marketing programs. Among its most important R&D achievements are: 1) in 1970, invented a new manufacturing process and specialized equipment for the production of drawstring bags; 2) in 1979, introduced the application of Linear Low Density Polyethylene to conserve energy resources and increase product performance in specialty bag manufacturing; 3) from 1984 and through 1977, developed water based ink printing systems to reduce air pollution when printing plastic films; and 4) in 1987, was the first bag manufacturer to nationally introduce corn starch based plastic bags in the U.S.

Amko's interest in degradable plastics began in 1985 with two incidents. First, in a meeting with representatives of Petrochemie Danubia G.M.B.H, Austria's state owned petrochemical firm, questions were directed to us about the feelings of U.S. consumers on the relationship between plastics and the environment. This issue was to be part of their analysis of investing in new plant capacity in Austria for the production of plastic resins. Second, we became aware that the Italian parliament was enacting legislation requiring the use of "biodegradable" plastic bags effective January 1, 1992.

Since 1985, Amko has interacted with companies in the investigation of plastics that are degradable in water, in organic solvents, by exposure to critical temperatures, by exposure to ultra-violet light (natural sun or artificial), and by the blending and compounding of biodegradable corn starch or rice starch throughout the film. Experimental production runs resulted in the introduction of a degradable bag program in November 1987.

DEFINING THE NEED FOR DEGRADABILITY

The Solid Waste Issue

We agree with the concern of Finding (4) of S.2298 that the management of a growing volume of solid waste is an urgent and fundamental environmental problem in this country. And, we recognize that plastic is a component of that solid waste volume.

However, since plastics in total comprise only 7 percent of the solid waste generated annually, we think the statement in Finding (5) of S.2298 that "plastic products comprise a significant (our emphasis) amount of the . . ." solid waste problem overstates the concern. And, with specific regard to plastic bags which make up less than 2 percent of the total, when one considers that paper bags occupy approximately 6 times the volume of comparable size plastic bags, the actual reduction of mass in a solid waste landfill resulting from the degradation of plastic bags is insignificant.

Moreover, a potential result of the overstatement above might be a self-fulfilling prophesy of generating even more plastic waste. Here's how. One of the current problems with today's starch based degradable plastics is that once the plastic product is made degradable, no manufacturer wants to recycle that material.

Since its inception, the plastics industry has been a major recylcer of its own materials. The economics of the industry are such that no company could survive if there were not either an in-house opportunity to recycle its own scrap or a ready market to sell its scrap for recycling into other products. For example, most of all the polyethylene film scrap generated by bag producers is either recycled back into their own new bags or is sold to companies who recycle the scrap in the manufacture of trash bags and liners. (That's why those bags are either black, dark brown or dark green; the dark color hides the vagaries of the scrap.)

However, once a starch based plastic begins to lose its strength because of starch biodegradation and/or oxidation, it loses its value as a recyclable material. At that point it becomes unusable. It becomes a new part of the solid waste stream . . . a part that did not exist prior its becoming a starch degradable plastic product.

Acceptance of starch degradable plastics by the plastics industry is dependent upon research and development of technologies that can address this vital performance and economic concern. Toward that end, we hope S.2298 can contribute to creating new technologies.

The Litter Issue

A second concern about plastics and the environment relates to litter. Because plastic has such a low density, it's a visible contributor; it is easily blown about on land and floats on water. In addition to its unsightliness, some litter poses a health risk to animals through ensnarement or entanglement. Degradation offers a prospect of reducing its long term presence. However, if a product is promoted and described as "degradable", people may more readily litter it, thinking the product will just disappear.

The Need For Degradation

S.2298 will encourage the development of degradable plastics. Technologies exist to accomplish that. But, we believe there should first be an analysis of the extent of the need for degradable plastics. In doing so, it's important to objectively quantify the current problem and project future results of the use of these new materials. We hope the research stimulated by S.2298 will thoroughly analyze these elements of the currently perceived problem.

HISTORICAL PLASTIC DEGRADABILITY

There's a major irony about today's new search for degradable plastics. For years plastic resin producers have blended anti-oxidants and ultra-violet light inhibitors into plastic materials to improve their stability and resistance to environmental degradation. The resins Amko purchases include these stabilizers. So, our efforts at introducing photodegradable, biodegradable, and oxidation characteristics into our films are, in fact, made more difficult by the presence of the basic stabilizers.

Accordingly, today's degradation agents might more accurately be described as accelerators rather than as initiators. So, to whatever degree accelerated degradation is desirable, part of the solution may come not only by the development of new additives for plastic resins, but also by the deletion of some of the old ones. The research promoted by S.2298 ought, we believe, to address these opportunities.

INTERNAL LANDFILL ACTIVITY

Part of Petrochemie Danubia's 1985 research included boring samples from landfills in Europe. The photographs they shared with Amko showed a startling lack of decomposition activity in materials one might think readily degradable. For example, going back 10, 15, and 20 years, samples of food and bone remnants were intact. And, newspapers were completely legible.

A great deal of analysis is underway on environmental activity in landfills. There's growing evidence that suggests minimal degradation takes place in landfills over considerable time, even with materials one sees decaying rapidly when subjected to land surface forces of sunlight, wind, water and physical impact.

Quantifying degradation activity in landfills and the desirability of that degradation are two important topics that should be examined by the research initiated by S.2298.

DEFINITION OF DEGRADABILITY

Degradability is defined in S.2298 by a single criterion: the "loss of utilitarian or physical characteristics of a plastic". This description seems to beg, however, quantitative standards of performance. For example:

1) To what degree must there be a loss of utilitarian or physical characteristics?
2) At what rate must degradation take place?
3) To what extent must degradation continue?
4) What are acceptable remnants of degradation?
5) What are acceptable by-products of degradation?
6) Who will establish the standards of degradation?
7) How will the standards be measured?
8) Under what environmental conditions must the standards be met?

Definition Establishes Expectations and Value

The issue of degradability of plastics has aroused more interest and inquiry from a greater variety of groups and individuals than any other single issue Amko has seen in its 22 year participation in the plastics industry. Amko's customers ask about performance and cost. Individual consumers ask about its friendliness to the environment. Other plastic processors ask what's expected and what's achievable. Educators want to know what they can teach their students. Legislators are doing more legislating than asking. Corn growers are asking, "where are all the plastic extruding and molding machines located?" Environmentalists ask about what's safe and what actually happens in degradation. Enviromaniacs (there is a difference) ask, "why use plastic at all?" And the news media ask about everything.

All the questions require quantitative responses. There seems no other way to establish reasonable expectations. Not only is the material's degradation itself an important characteristic, but so are its functional performance and value for bag users and consumers.

The following illustrates this point. For a number of reasons, 6% starch in film is the loading value currently recommended by corn starch additive suppliers. Starch degradable plastic is weaker than conventional plastic. Generally speaking, as more corn starch is added into the plastic material, the weaker the material becomes. To overcome this weakness in some applications, the film must be extruded thicker, at even greater raw material use and cost.

Even without increasing the film thickness, lack of standards can create cost disparities. Depending on bag style, size and film thickness, current costs are increased over conventional films by between 8% to 20% with the addition of 6% corn starch in the finished product.

The percentage of starch has a major influence on the rate of degradation. If agreed-upon standards of degradation are not established, one producer can offer only a 1% starch loading at a distinct cost (and performance) advantage and still claim the product is "degradable". Yet, what expectations of performance and degradability did the customer have when placing the order; what were the differences in performance and true value offered by the 6% loading producer and the 1% producer; and, did the customer understand all the differences?

There is clearly a performance/cost compromise in delivering degradable products to customers and consumers. Resolving the important issues about the definition of degradability - bio and photo - would be a major contribution of the increased research stimulated by S.1198.

FUTURE COST CONSIDERATIONS OF DEGRADABLE PLASTIC BAGS

Today's market price of our major resin, Linear Low Density Polyethylene, is about $.52 per pound. The current price of the starch additive concentrate (43% starch; 57% polyethylene) is about $1.25 per pound. As indicated above, adding 6% corn starch (approximately 15% concentrate) to our products adds between 8% and 20% to our prices. The amount of starch loading directly affects pricing. Since today's starch additive concentrates are produced in relatively small individual batches, one would expect the cost of the concentrate to drop (relative the cost of polyethylene) as future demand grows to stimulate continuous stream production methods. As those economies of scale are realized, the cost premium for corn starch additives ought to be reduced.

CONCLUDING THOUGHTS

The plastics industry is a major, world wide enterprise. The performance and value of its materials and processes reflect its historic technological achievements. They have stimulated continuing customer demand for more uses of existing plastic materials and for the development of new ones. The plastics industry's innovative prowess holds strong promise for its contribution to the development of degradable additives and polymers.

Currently, however, we believe there are many uncertainties as to objectives, needs, definitions, and standards applying to degradable materials, plastic and otherwise. Prior to there being mandated uses, we think there should be thoughtful research and analysis to investigate the issues and answer the questions being asked about degradable plastics by so many people, within the United States and around the world. We hope that, before enactment, the "Agricultural Commodity-Based Plastics Development Act of 1988" will address all the issues and questions its enactment would raise.

STATEMENT BY SENATOR KENT CONRAD
BEFORE THE GOVERNMENTAL AFFAIRS COMMITTEE
UNITED STATES SENATE
ON
S.2298, THE AGRICULTURAL COMMODITY-BASED PLASTICS ACT OF 1988
SEPTEMBER 20, 1988

I am honored to testify before this Committee regarding S. 2298, the Agricultural Commodity-Based Plastics Act of 1988. I want to commend the Chairman, Senator Glenn, for his leadership and foresight in expanding new industrial uses of agricultural commodities through this bill and other initiatives.

I believe that the development, production and marketing of new industrial uses represent one of the most significant opportunities we have to expand our economy. That's why I join Chairman Glenn in his efforts to establish a national commitment to developing and commercializing new industrial uses for agricultural commodities. I strongly support S. 2298, which would require the Federal government to procure biodegradable plastics for use by Federal agencies. It will encourage the development of biodegradable plastics made from agricultural commodities, in this case corn, to move them into the consumer market.

Senator Glenn's bill identifies a primary obstacle to successful commercialization of new uses. This obstacle is market development. These biodegradable plastics are not quite competitive with petroleum-based plastics. By providing a large, stable market for these plastics, we can reach a level of price competitiveness and production efficiency that is necessary to attract manufacturers and consumers. Once this early market development is achieved, these plastics have a remarkable chance to capture a significant market share of our plastics demand.

Why should the government get involved in private sector efforts to commercialize new industrial products derived from agricultural commodities? Because new uses development has the potential to address many public concerns, including the environment, agricultural surpluses, the rural economy, our national economy and our trade deficit. Let me just briefly describe the tremendous impact new uses development will have on these important areas.

First, starch-based plastics are biodegradable. In an era in which Americans discard nearly 15 million tons of plastic

products each year, when our municipal landfills are reaching their capacity and our oceans are being polluted with plastics, biodegradable plastics provide an excellent opportunity to protect our environment.
Current technology enables us to replace 30-45 percent of the low density polyethelene plastics currently used with biodegradable plastics. In addition, research is underway to develop other biodegradable starch-based plastics, including polystyrene, which most of us recognize as styro-foam. We cannot ignore this tremendous opportunity to reduce our nation's solid waste disposal problem.

Second, starch-based biodegradable plastics are an additional use for one of our nation's most abundant renewable resources -- grain. Our farmers have a tremendous capacity to produce agricultural commodities. Unfortunately, instead of opportunities, that capacity has frequently brought surpluses, low prices and contributed to the bankruptcy of many farm businesses. To combat these problems, we have established farm programs to suppress grain production and support grain prices. These farm programs come at tremendous cost to the federal government.

There is a way to harness this tremendous grain production capacity: through the development of new uses for agricultural commodities. For example, it has been estimated that 300 million bushels of corn could be used to produce the biodegradable plastics I discussed earlier. This increased demand for corn and other grains will improve grain prices for our farmers and greatly reduce the cost of our farm program.

Third, new industrial uses for agricultural products represents an opportunity to revitalize our rural economy. The farm recession, and farm programs designed to reduce production, have imposed a real economic hardship on local businesses which serve farmers. The increased demand for grain will increase demand for the products and services of rural agricultural businesses. In addition, the new industries which manufacture these products will logically locate near the source of the raw material, thereby bringing new businesses and new jobs to rural areas.

Fourth, the development of new industrial products will result in new products for sale both domestically and abroad. This will improve our balance of trade with other countries. Just as important, the production of plastics made from domestically-produced grain starch will reduce our nation's demand for imported petroleum. This, too, would have a tremendous positive impact on our trade balance.

More jobs, a healthier rural economy, reduced imports, new export products, reduced solid waste pollution, reduced farm program costs: all of these benefits are within our reach if we pursue the development of biodegradable starch-based plastics and other new industrial uses of agricultural commodities. We simply must grab this opportunity.

I feel so confident about this undertaking that I, along with Senator Glenn, Senator Bond, and Congressman Tim Penny, have introduced legislation to establish the Agricultural Research Commercialization Corporation. ARCC will form a partnership between the Federal government, private industry, universities, and state and local governments to encourage the development and commercialization of new uses. This measure has been included in a research bill recently approved by the House Agriculture Committee, and is part of a rural development initiative pending in the Senate Agriculture Committee.

It is efforts like this, and S. 2298, which will ensure that our nation takes full advantage of the economic opportunity provided by the development of new industrial uses. I give my full support to Senator Glenn's bill, and shall work for its passage.

Thank you, Mr. Chairman.

TESTIMONY OF SENATOR ALAN J. DIXON
BEFORE THE COMMITTEE ON
GOVERNMENTAL AFFAIRS
SEPTEMBER 20, 1988

I wish to commend Senator Glenn and the members of this Committee for using this forum to highlight a most promising future for American agriculture. In addition to our traditional uses, research in alternative uses of agricultural commodities has demonstrated that there are vast new industrial markets for agricultural products. Alternative uses -- such as soybean ink, road de-icers, and degradable plastics -- offer new opportunities for reliable domestic markets.

Degradable plastics enable us to utilize our Nation's renewable agricultural resources in an effort to combat many of the serious environmental problems looming over us. Although not the only or final solution, cornstarch plastics offer an important response to the pressing environmental problem of solid waste disposal. Plastics comprise 7% of the 150 million tons of solid waste produced in this country each year. By the year 2000, this is expected to rise to 10%. By 1990, more than 1/2 of the cities in the U.S. will exhaust their current landfills.

At the same time, the commercialization of degradable cornstarch plastics will provide an important step in restoring prosperity to farmers. It has been estimated that the use of agricultural commodity-based plastics could create a new market for approximately 150 million bushels of corn each year.

Today, we possess technologies to produce degradable plastic products at costs competitive to, or cheaper than, nondegradable plastics. Cornstarch, combined with conventional plastic resins, can be utilized to produce a whole host of products. We currently see these uses in plastic packaging, plastic bags, milk jugs, food trays, foam cups, and oil bottles.

I am pleased to be a cosponsor of Senator Glenn's bill, "The Agricultural Commodity-Based Plastics Development Act of 1988." This bill will play an important role in promoting the development and use of degradable plastics markets. There are 20 to 30 degradable cornstarch plastic items that are currently available for utilization. By including these products in the General Services Administration's inventory, we are affirming that our federal government is committed to the development of these new agricultural products in practice, as well as in theory.

Degradable cornstarch plastics, and other alternative uses of our agricultural products, will greatly contribute to the restoration of a viable agricultural economy. They will enable us to meet the many environmental challenges threatening us today, while at the same time offering new economic opportunities for our rural communities.

I wish to thank the Chairman and the Committee for the opportunity to address you today on this most important issue, and commend you for your outstanding efforts.

United States General Accounting Office

GAO

Report to the Chairman, Committee on
Governmental Affairs, U.S. Senate

September 1988

DEGRADABLE PLASTICS

Standards, Research and Development

GAO/RCED-88-208

GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-232185

September 20, 1988

The Honorable John Glenn
Chairman, Committee on Governmental Affairs
United States Senate

Dear Senator Glenn:

In your letter of January 19, 1988, you asked us to conduct a study of federal government activities that encourage the research and development (R&D) of degradable plastics. As agreed to in subsequent discussions with your office, this report

- identifies the extent of federal and private sector efforts relevant to developing standards for degradable plastics and
- describes federal agencies' support of degradable plastics R&D.

Results in Brief

Overall, we found that the federal government and the private sector are making only limited efforts to develop standards for degradable plastics. Along with the growing interest in commercializing degradable plastics, scientists and management officials in both government and industry recognize that standards need to be developed before these plastics can have widespread use. Such standards would include uniform definitions and methods of testing to evaluate product performance and would help assure consumers of a satisfactory product. They would also facilitate manufacturers' compliance with existing and potential legislation mandating the use of degradable plastics.

Furthermore, we found that federal agencies' support of degradable plastics R&D has been limited. Federal expenditures in fiscal year 1988 total $1.7 million for 12 projects emphasizing the development of new degradable plastic materials. These projects include very basic research and applied R&D intended for specific uses. The federal agencies supporting these activities, however, are not among those that could undertake the formulation of standards. In addition, virtually no testing of degradable plastics has been done; the limited testing that is planned or is being conducted may help to evaluate product performance but does not ensure the establishment of standards for degradable plastics.

Background

The mounting problems posed by the permanency of plastics in municipal solid waste, litter, and marine pollution have led to a search for solutions, including the use of degradable plastics. Unlike traditional plastics, which may persist in the environment for centuries, degradable plastics are intended to disintegrate in a matter of months through degradation by sunlight (photodegradation) or microorganisms (biodegradation). They thus may be able to reduce the life span of litter in the landscape and at sea; they may also diminish the amount of plastics accumulating in landfills. In addition to their potential environmental benefits, degradable plastics offer new opportunities for the use of agricultural commodities. Cornstarch, in particular, is a leading ingredient.

Need to Develop Standards for Degradable Plastics

We found widespread concern among officials and scientists about the current lack of standards. Definitions of such basic terms as biodegradation and photodegradation have not yet been agreed upon, nor have uniform methods of testing been developed. Very little testing of degradable plastics has been done to support the development of standards. Testing remains necessary to resolve two basic technical uncertainties about the performance of degradable plastics in the environment: the rate of degradation and the safety of the end products. Issues relating to the rate of degradation include the possibility that degradation may occur before the product has served its purpose or that it may occur too slowly to provide an effective solution to environmental problems. Safety-related issues include the potential toxicity of chemicals leaching from degradable plastics and the size of the plastic fragments resulting from degradation.

Among government agencies with the capability to standardize or test new materials and products, the Environmental Protection Agency (EPA), National Institute of Standards and Technology (NIST), and Food and Drug Administration (FDA) reported few or no activities involving degradable plastics. EPA has laboratories capable of addressing the technical uncertainties but has not targeted resources on these concerns, primarily because of other priorities. NIST is planning one experiment to evaluate degradable plastics but has no program underway. FDA has not approved any additives that are intended to increase the degradability of plastic food-packaging materials. However, the agency has recently been contacted by, and is working with, companies that are interested in food-packaging uses of degradable plastics.

In the private sector, the American Society for Testing and Materials (ASTM) is preparing to develop formal definitions and methods of testing.

ASTM, supported by private firms, describes itself as the world's largest source of voluntary consensus standards. It operates through numerous technical committees. One of these, the Committee on the Permanence Properties of Plastics, is chiefly responsible for ASTM's efforts to develop uniform definitions and methods of testing. These activities have begun so recently, however, that their contribution to developing standards for degradable plastics is difficult to evaluate at present.

Federal R&D for Product Development

Four federal agencies are conducting or supporting basic or applied research related to the degradability of plastics and product development. The Departments of Agriculture (USDA), Defense (DOD), and Energy (DOE) and the National Science Foundation (NSF) are supporting 12 R&D projects at a total funding level of $1.7 million in fiscal year 1988.

- USDA is spending $941,000 for degradable plastics research aimed at developing new nonfood, nonfuel uses for agricultural commodities, particularly corn.
- DOD's R&D program, accounting for $575,000, is focusing on developing an alternative to nondegradable plastics for use at sea.
- DOE has provided $150,000 to develop wood- and starch-based substitutes for petroleum-based plastics.
- NSF has awarded a grant for $63,000 to improve the technology for developing plastics based on cornstarch and wood.

In addition, although supporting no direct R&D, the Department of Commerce has completed a technical study; further studies are underway at EPA and the Office of Technology Assessment (OTA). The Commerce Department established the Interagency Task Force on Persistent Marine Debris, which assessed the problem of plastics at sea and recommended ways of mitigating it. EPA, in response to the Marine Plastic Pollution Research and Control Act of 1987 (P.L. 100-220, sections 2001-2305), is conducting a study on methods to reduce plastics pollution. OTA, too, is evaluating different technologies and long-term strategies for reducing and managing municipal solid waste. Both EPA and OTA are assessing the potential role of degradable plastics in addressing these concerns.

Several bills, including S. 2298, which you have proposed, have been introduced in the Congress and in state legislatures to promote or mandate the use of degradable plastics. Sixteen states already have enacted legislation requiring the use of degradable plastics in six-pack yokes. The majority of these state laws, however, provide no definitions, time frames, or requirements for the safety of the end products of degradability.

Matter for Consideration by the Congress

Given the consensus on the need to develop standards for degradable plastics and the currently limited efforts within the federal and private sectors to formulate such standards, the Congress may want to consider the following approach if it wishes to promote degradable plastics: Select an agency (or agencies) which, in cooperation with the private sector, would undertake the development of standards, including uniform definitions and methods of testing for degradable plastics. EPA and NIST would be appropriate agencies for such activities because of their extensive experience in testing for environmental effects and product performance. If such standards are developed, the Congress may want to incorporate them in any legislation promoting the use of degradable plastics.

Our report does not attempt to evaluate the relative merits of product degradability versus other approaches (such as recycling) to alleviating the solid waste problem associated with traditional plastics. Reports by EPA and OTA will compare degradable plastics with other alternatives in developing an overall strategy. Efforts to promote the use of degradable plastics, according to an OTA official, should take into account their effectiveness in reducing solid waste and their compatibility with alternative approaches.

Our report is based on information obtained from federal officials, project officers, academic researchers, trade associations, and industry representatives. In addition, we reviewed technical literature, legislation, and reports by specialized task forces. Because of our report's informational nature, we did not obtain agency comments on a draft of this report. Our audit work was conducted between February and July 1988.

We are sending copies of our report to the heads of federal agencies contacted during this review and to others upon request. This report was prepared under the direction of Flora H. Milans, Associate Director. Major contributors to this study are listed in appendix IV.

Sincerely yours,

J. Dexter Peach

J. Dexter Peach
Assistant Comptroller General

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Abbreviations

ASTM	American Society for Testing and Materials
DOD	Department of Defense
DOE	Department of Energy
EPA	Environmental Protection Agency
FDA	Food and Drug Administration
FY	fiscal year
NIST	National Institute of Standards and Technology
NOAA	National Oceanographic and Atmospheric Administration
NRRC	Northern Regional Research Center
NSF	National Science Foundation
OTA	Office of Technology Assessment
R&D	research and development
SPI	Society of the Plastics Industry
USDA	U.S. Department of Agriculture

Appendix I

Technology and Uses for Degradable Plastics

The numerous advantages of plastics—their strength, durability, lightness, flexibility, and low cost—have led to their widespread use. They are employed extensively in the packaging industry, transportation, agriculture, commercial fisheries, and other market sectors. They have been used to replace glass in bottles, metal in automobiles, and natural fibers in large nets used in commercial fishing. The use of plastics is especially evident in packaging, which accounted for about 11.5 billion pounds, or 25 percent, of total plastics usage in 1986.

The very success of plastics, however, has created problems with their disposal as litter or municipal solid waste. Their strength and durability, which enable them to endure for long periods of time, pose aesthetic or environmental problems. As an example of the extent of marine pollution, the Woods Hole Oceanographic Institution reported as many as 46,000 pieces of plastic per square mile at sea. Ten miles of plastic netting from Asian commercial fishing operations alone are lost every day at sea, creating a hazard to marine life. Ingestion of plastic by marine animals has been documented among seabirds, fish, turtles, and whales. A report prepared by the Office of Technology Assessment (OTA) concluded that tens of thousands of seabirds and an estimated 100,000 marine mammals die each year by ingesting or becoming entangled with plastic debris.[1]

The growing share of plastics in municipal solid waste is also stirring concern about their disposal. The percentage of the waste composed of plastics nearly doubled between 1976 and 1984, equaling 7.2 percent, or about 9 million tons. The growing reliance on plastics, coinciding with a steep decline in the number of landfill sites where the wastes may be deposited, has led to mounting concerns about the looming crisis in plastics waste disposal.

Consideration is being given to degradable plastics as one means of alleviating such problems. Unlike traditional plastics, which may last 200 to 400 years, degradable plastics may deteriorate in a matter of months. Degradable plastics may thus be able to reduce the life span of litter in the landscape and at sea; they also may diminish the amount of plastics accumulating in landfills. Technical uncertainties about the performance of degradable plastics, however, have stirred some questions about their ability to alleviate these problems. (For a discussion of technical uncertainties, see app. II). As a result, some experts contend that recycling and incineration may be more effective responses to the environmental problems posed by plastics.

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[1] Office of Technology Assessment, Wastes in Marine Environments (OTA-O-334), April 1987.

In addition to their potential environmental benefits, degradable plastics offer new opportunities for the use of agricultural commodities. Cornstarch, in particular, is a basic ingredient for making a degradable plastic. Assuming that cornstarch could penetrate 5 percent of the packaging market, the National Corn Growers Association has estimated that this use could consume more than 19 million bushels per year. Proposed legislation in the Senate (S. 2298) observes that degradable plastic products made from agricultural commodities can also reduce U.S. reliance on imported oil, a principal ingredient in traditional, durable plastics.

The private sector has responded to this growing interest in degradable plastics. The Society for the Plastics Industry, a trade organization of more than 1,900 members representing all segments of the plastics industry in the United States, held a symposium on the subject in June 1987. The symposium was attended by a wide range of representatives from large corporations, small manufacturers of degradable plastics, and environmental and research-oriented organizations. In addition, manufacturers have marketed some degradable plastic products, although such products tend to be somewhat more expensive than nondegradable plastics.[2] Companies are also conducting research and development (R&D) to test the performance of new degradable plastics.

In addition, local, state, and federal governments have promoted the use of degradable plastics. Local and state governments across the country have proposed bills to ban such nondegradable plastic products as fast-food packaging; certain wrappings for fruit, cheese, and meat; six-pack yokes; egg cartons; grocery bags; and liquor bottles. As of July 1988, two local jurisdictions—Berkeley, California, and Suffolk County, New York—have enacted legislation prohibiting nondegradable fast-food packaging. Sixteen states have enacted legislation requiring the use of degradable plastics in beverage containers.

At the federal level, on April 2, 1987, 30 Senators requested that the President assist in developing a coordinated strategy to resolve marine problems resulting from plastic debris. Subsequently, the Department of Commerce organized an Interagency Task Force on Persistent Marine

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[2] A Congressional Research Service Issue Brief, "Degradable Plastics" (June 8, 1988, IB88067), stated that on average, degradable plastic products cost about 3 to 14 percent more than conventional plastic goods.

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Debris, an 11-agency task force addressing the potential role of degradable plastics. Since January 1988, several bills have also been introduced in the House and Senate to promote or mandate the use of degradable plastics.

Ways of Making Degradable Plastics

Current technology produces plastics that are considered nondegradable because they degrade only over long periods of time (from 200 to 400 years). These nondegradable plastics are synthesized from petrochemicals to create long chains of repeating molecules known as polymers. The synthetic polymers account for much of the strength and durability of plastics. In addition, they are chemically inert and resistant to attack by microorganisms. Scientists have sought to make them resistant to other kinds of degradation as well.

Environmental concerns in the 1960s, however, fostered research to make plastics more degradable. This early research focused on materials that could be broken down by sunlight. Research since has been broadened to include blends of synthetic and natural polymers. Unlike synthetic, petroleum-based polymers that have traditionally been used in making plastics, natural polymers such as starch are susceptible to attack by microorganisms.

Photodegradation and biodegradation are the two most often considered ways of degrading plastics. The former relies on the sun's ultraviolet light to decompose the physical and chemical structure of the plastic. The latter makes use of microorganisms to break the plastic into smaller fragments or to disintegrate it completely.

Photodegradation requires the use of certain chemical additives in plastic that are sensitive to sunlight. These chemicals, such as carbon monoxide, are included at intervals in the polymers. Sunlight is able to decompose the plastic at these points, resulting in shorter molecular chains which render the plastic brittle and hasten its disintegration. Given an initial exposure to sunlight, one particular type of photodegradable plastic, using an "auto-oxidant/photoactivator system," is claimed to continue degrading even in the absence of sunlight or oxygen. This characteristic may enable the plastic to decompose even if it is buried in a landfill.

Biodegradation requires the blending of natural and synthetic polymers and their exposure to a moist environment with an active microbial population. The natural polymer is recognized as food by bacteria and fungi, which release enzymes that help to disintegrate it. One approach to biodegradation, which is already being commercialized, involves the inclusion of starch as the natural polymer. The starch degrades completely, reducing the remaining plastic to smaller fragments that may in turn become susceptible to further biodegradation. A second approach involves a biodegradable plastic that is produced through the use of microorganisms. A third approach to biodegradable plastics relies on the use of cellulose, specifically wood fibers. Additional methods are being developed to produce a variety of degradable plastics. With the need for moisture and microorganisms, biodegradation of surface litter may be limited and is more likely to occur in landfills or on the seabed.

Technical Innovation

The technologies for producing degradable plastics, according to the technical director for a large company entering the degradable plastics market, are in a state of considerable flux and improvement. A scientist directing the polymers division of a large chemical corporation told us that researchers need to learn how to "unzip" polymers as effectively as they have learned how to make them virtually indestructible. In an effort to improve degradable plastics, companies are reviewing older techniques and searching for innovations. Following are two among many examples of the innovative research underway.

The bond between synthetic and natural polymers is a limiting factor in the current technology but is considered capable of improvement. Plastics and natural polymers such as starch are basically incompatible. As a result, the present blends in biodegradable plastics are generally able to incorporate no more than 6 to 10 percent of the natural polymer in the finished product. Blends that attempt to include a higher percentage lose a proportionate amount of strength.

Research sponsored by the Department of Energy (DOE) is aimed at developing a bond to hold the synthetic and natural polymers together more effectively. It involves efforts to manipulate the synthetic polymer, the natural polymer, and a compatibilizer or "glue," each engineered to interlock with the other. Development of an improved bond will enable scientists to boost the percentage of the natural polymer to levels as high as 25 to 35 percent with no loss of strength. In turn, the by-products of bacteria acting to degrade the natural polymer may also attack the remaining synthetic polymer more effectively.

Research sponsored by the Department of Defense (DOD) relies on special strains of microorganisms to produce a plastic that degrades completely into carbon dioxide and water. Scientists are investigating numerous types of these microorganisms capable of producing a variety of these degradable plastics. By controlling the food consumed by the microorganisms, scientists are able to stimulate the production of fatty materials with plastic properties. They are also learning how to direct the microorganisms' production of such plastics to obtain polymers with specially designed characteristics.

Uses for Degradable Plastics

The current uses of degradable plastics are limited to a few products and have been commercialized only to a minimal extent. The products include six-pack yokes, plastic bags for carrying trash, and mulching films for agriculture. Expectations about the potential market point toward specialized uses. An overview presented at the Society of the Plastics Industry (SPI) June 1987 symposium concluded that degradability can be beneficial and cost- effective if it is applied selectively. Manufacturers of degradable plastics believe that markets can be expanded in packaging, agricultural films, and other areas requiring short-term uses for plastics.

Degradable six-pack yokes are useful in reducing litter and the risk to wildlife of entanglement in the loops. Several large plastics manufacturers have responded to the problem of six-pack yokes by marketing a degradable plastic material (a resin) that can be used in making the yokes. The resin incorporates additives that are photodegradable. These degradable packaging materials are mandatory in numerous states.

Degradable plastic bags have been developed but have obtained only a limited share of the market. Degradable plastic trash and grocery bags, for example, are sold by only a few companies on a local or regional basis. The National Corn Growers Association, in an effort to promote degradable plastic grocery bags incorporating cornstarch, has begun distributing samples.

The use of plastic mulching films in agriculture has become widespread. The films are designed to reduce the number of weeds, loss of fertilizer, the rotting of fruit, and other problems. The National Agricultural Plastics Association estimated that, in 1985, about 125 million pounds of plastic mulch films were sold in the United States. The Association estimates that farmers are using up to 500 pounds of nondegradable plastic film per acre and paying more than $100 per acre for its removal. Although biodegradable plastics have not yet been used extensively for this purpose in the United States, they may be employed more widely because of the cost of removing the nondegradable plastics from the fields.

Packaging is an area that may be appropriate for degradable plastics. About 25 percent of the plastics sold in the United States is used in packaging and other short-life applications. Plastics are applied in packaging for wrapping and laminating; they are also used in bottles and numerous other containers for carrying and protecting food. Some packaging used for fast foods has an estimated service life of only 3 minutes but may persist as litter for centuries. As a result, applications in packaging may become an attractive market for degradable plastics.

Objectives, Scope, and Methodology

In a letter dated January 19, 1988, Senator John Glenn, Chairman of the Senate Committee on Governmental Affairs, asked us to conduct a study of federal government activities in the area of degradable plastics. We subsequently agreed with the Chairman's office to (1) identify the extent of federal and private sector efforts relevant to developing standards for degradable plastics and (2) describe federal agencies' support of degradable plastics R&D.

Our report does not attempt to evaluate the relative merits of product degradability and other approaches (such as recycling) to alleviating the solid waste problem associated with traditional plastics. We restricted our scope in this regard because studies underway at the Environmental Protection Agency (EPA) and OTA will evaluate degradable plastics in conjunction with other approaches to achieving solid waste management objectives.

During our review, we contacted officials and scientists in the federal government and the private sector. We talked with officials and scientists in the Department of Agriculture (USDA), DOD, DOE, and the National Science Foundation (NSF), as well as EPA, NIST, the Department of Commerce, and the Food and Drug Administration (FDA), to identify federally funded R&D and activities relating to standards for degradable plastics. In the private sector, we contacted officials and scientists in companies, trade associations, and the American Society for Testing and Materials (ASTM) to identify concerns about the need for standards. We further contacted officials in Suffolk County, New York, and Berkeley, California, to obtain their legislation banning nondegradable plastics.

In addition, we reviewed a wide range of popular and technical literature on plastics and the development of degradable plastics.[1] Federal managers and scientists associated with degradable plastics projects furnished us with detailed information on their activities. Manufacturers of degradable plastics provided brochures, technical analyses, and samples of their products. We also reviewed existing state and local laws relating to degradable plastics.

We coordinated our study with OTA, which is preparing an extensive analysis of municipal solid waste issues and the role of plastics. Because of its informational nature, we did not obtain agency comments on a draft of this report. Our analysis was performed from February to July 1988.

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[1] An especially useful document is the Proceedings of the SPI Symposium on Degradable Plastics, Society of the Plastics Industry, June 10, 1987, Washington, D.C.

The Need to Develop Standards for Degradable Plastics

Greater interest in degradable plastics has led to the recognition of the need to develop standards for them. This development would include agreed-upon definitions of such basic terms as photo- and biodegradation. It would also include the formulation of accepted methods of testing to evaluate performance characteristics. Such standards would help assure consumers of a satisfactory product and facilitate manufacturers' compliance with state and local government legislation and potential federal legislation requiring the use of degradable plastics for specific applications.

Very little testing, however, has been undertaken to date to determine the performance characteristics of degradable plastics and help in establishing standards. As a result, technical uncertainties involving the timing and rate of degradation and the safety of the end products remain unsettled. The federal and private sectors possess the resources to resolve these uncertainties but have begun only recently to respond to the problem. Certain federal agencies—most notably EPA, the National Institute of Standards and Technology (NIST), and FDA—are capable of evaluating the performance of degradable plastics but are involved in this area to only a limited extent. ASTM, the principal private organization responsible for developing standards, is beginning to formulate definitions and methods of testing. In addition, a trade association is conducting a limited testing program for degradable plastics. The testing that is planned or underway may help to evaluate product performance but does not ensure the establishment of degradable plastics standards.

This appendix discusses the need to develop standards for degradable plastics. It reviews the main technical uncertainties that have been identified. It also examines the resources and activities committed to standards development by EPA, NIST, FDA, and the private sector.

Lack of Standards

Private and federal officials and scientists have expressed concern about the current lack of standards. Officials we spoke with considered the absence of uniform definitions and methods of testing to be a source of confusion regarding degradable plastics. The director of the plastics department at a major corporation described the situation of degradable plastics as "a state of chaos." Another official with a large corporation involved in developing degradable plastics said that inconsistent definitions of biodegradability in particular are causing considerable confusion. The technical director for an industry trade association stated that degradability needs to be defined and uniform methods of testing need to be developed. A scientist conducting research on degradable plastics at the Massachusetts Institute of Technology described the problem as follows:

> "Most of the biodegradability studies are very ill-defined, not quantitative and not standardized as to what is biodegradable. The community in this area has not reached satisfactory standards or procedures allowing for uniform comparison of biodegradability. There is a need for further development of policies and procedures for this critically important area."

Standards, according to various officials, also need to be developed as a basis for effective legislation. Officials are concerned that the current lack of standards may lead to unrealistic or confusing legislation. One technical director of a degradable plastics program at a major corporation stated that legislators are trying to write laws with no suitable guidelines, as exemplified by Italy's legislation banning nondegradable packaging; Italy's law does not clarify what is meant by degradability or what standards are to be met. This official is concerned that a similar situation, in which producers would not know whether they were in compliance with the law, could develop in the United States.

Although 16 states have enacted legislation requiring the use of degradable plastics in six-pack yokes, few of the states have provided definitions, time frames, or requirements for the safety of the end products of degradability. Legislation in a majority of these states is relatively simple and nontechnical. Nine of these states provide no definitions of degradability, 10 states specify no time frame, and 11 states provide no requirements regarding the safety of the end products. The definitions, when provided, refer mainly to general processes, including photo- and biodegradation, while giving no further details. Time frames, when specified, vary between 120 days in Florida and 5 years in Minnesota. Of the five states with end product safety requirements, only two states require that both the particle size and chemical composition of degradable plastic fragments be established as safe.

Areas of Technical Uncertainty

Along with the lack of standards, two important technical uncertainties associated with degradable plastics remain to be addressed: (1) the initiation and rate of degradation and (2) the safety of the end products resulting from it. Some scientists and industry officials are concerned that degradation may occur before the product has served its purpose or that it may occur too slowly to provide an effective solution to environmental problems caused by persistent plastics. Safety-related issues include the potential toxicity of chemicals leaching from degradable plastics into the environment or into food from plastic packaging. In particular, chemical additives used in plastics to improve their durability and other properties may be released during degradation.

These technical uncertainties also have implications for other approaches to addressing solid waste management problems. Their resolution would contribute to decision-making about the best mix of strategies in this area. These other strategies include recycling, incineration, and waste stream reduction.

The limited amount of testing of degradable plastics accounts in part for these technical uncertainties. A scientist conducting research on degradable plastics for DOD and the Department of Commerce told us that there has been virtually no testing and, consequently, no demonstration that the materials will perform properly in degrading. He stated:

> "Neither the exact sequence nor the time scale for any of the natural stages of deterioration of any of the plastics have been determined, especially with regard to performance in the marine environment."[1]

He also told us that future research should focus on experimentation to demonstrate effective degradation.

Control over the initiation and rate of degradation remains uncertain. Diverse environmental conditions play important roles. Plastics may be dumped into the ocean, where they float or sink, scattered as litter on the surface of the land, buried in a landfill, mixed with soil as a mulching film, or used as a container or a lining in contact with food. Consequently, exposure to the two primary agents affecting the start and rate of degradation, sunlight and bacteria, may differ to a considerable degree.

As a result, the technical challenges for degradable plastics are avoidance of a premature failure and disintegration within a suitable time frame once they are no longer needed. According to the overview presented at SPI's June 1987 symposium, degradable plastics in proposed applications such as packaging have not been carefully tested to ensure that the contents are not lost or contaminated through an early failure of the packaging. It further noted that, on the other hand, some plastics may degrade too slowly in landfills. A representative for an environmental group, citing the dangers posed by nondegradable plastics to marine life in particular, emphasized the need to determine whether degradation can occur rapidly enough to reduce the hazards of plastics in the environment.

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[1] Report of the Interagency Task Force on Persistent Marine Debris, May 1988, p. 105.

The safety of the end products resulting from degradation is also a concern. According to a manufacturer of degradable plastics, it is important to distinguish between (1) the breakdown of a plastic object into small, dispersible, undegraded plastic fragments by the action of microorganisms on fillers such as starch and (2) the true breakdown of the polymers to natural end products that may safely enter the environment.

The SPI degradable plastics overview stated that the end products of degradable plastics are not well understood, so their toxicity and environmental effects remain unknown. Effects on groundwater and soils are not well known and could add to the burden already placed on the environment by materials degrading in landfills. According to a state environmental official, biodegradable products in landfills will form undesirable products such as methane gas, one of the major problems with all current landfills. In addition, the leaching of degradable plastic additives into the environment and contamination of foods in contact with packaging materials have been cited as potential hazards.

Some manufacturers of degradable plastics have stated that they are able to control the rate of degradation and the safety of the end products. On the basis of field trials, a manufacturer of an agricultural mulching film, for example, indicated that the time for degradation of the film is predetermined and can be varied according to the location, season, and time of application. The manufacturer claims that predictable times ranging between 3 weeks and 12 months have been achieved. According to a manufacturer of the bacteria-produced plastic that is claimed to disintegrate completely into carbon dioxide and water, it is stable in storage and harmless during degradation. In general, however, such claims have not eliminated the concerns about the technical uncertainties associated with degradable plastics.

Limited Efforts to Resolve Technical Uncertainties

In spite of the need to address technical uncertainties and develop standards, only limited efforts are underway. Among the federal agencies that we contacted, EPA could address the technical uncertainties through several of its laboratories but has not targeted resources on these concerns, primarily because of other priorities. NIST and FDA have indicated recent but limited involvement in this area. Regarding the private sector, ASTM is beginning to develop formal definitions and methods of testing. One trade association is conducting tests to evaluate the performance of degradable plastics. In general, however, activities related to standards development for degradable plastics are somewhat limited in both the public and private sectors.

Federal Activities

Among the many government agencies becoming concerned with degradable plastics, EPA, NIST, and FDA have responsibilities that relate to the development of standards and testing of new materials and products. EPA conducts a variety of studies that relate to the degradability and safety of many products, including plastics. NIST's Polymers Division is directly concerned with testing and evaluating plastics. FDA, charged with protecting the public safety where food is concerned, has recently begun to work with companies interested in the use of degradable plastics in food-related packaging. The extent of these agencies' activities is discussed in further detail below.

Environmental Protection Agency

Several laboratories within EPA's Office of Research and Development are capable of conducting tests to address the technical uncertainties about degradable plastics, but no testing in this area is underway, primarily because of other priorities. The Deputy, Office of Environmental Processes and Effects Branch, said that the Office of Research and Development has a major program concerning the stability and transport of chemicals in the environment. The testing of degradation rates and the safety of end products of plastics, according to the Deputy, would be consistent with previous work that EPA has done. The Deputy indicated that such a task would be relatively easy to perform and could be conducted in a cursory or a very thorough manner.

Several of EPA's laboratories described their ability to address the technical uncertainties. The Gulf Breeze Laboratory (Gulf Breeze, Florida) would be able to evaluate the biodegradation of plastics. The Environmental Research Laboratory (Athens, Georgia) could address both bio- and photodegradation. The Robert S. Kerr Environmental Research Laboratory (Ada, Oklahoma) conducts research on the mechanisms and rates of degradation of chemicals in groundwater and could apply this expertise to degradable plastics in general.

A fourth EPA laboratory, the Risk Reduction Engineering Laboratory (Cincinnati, Ohio), conducts a program involving the biodegradation of hazardous wastes. It evaluated various plastics and their biodegradation in the early 1970s.[2] The Deputy Director stated that social concerns are broadening from hazardous waste to include municipal solid waste problems and that the laboratory has the capability to address the technical uncertainties.

EPA officials said that although the laboratories possess the capability, no tests of degradable plastics are underway. The laboratories are faced with numerous other research and testing priorities. As a result, any effort involving degradable plastics would probably be somewhat limited. An EPP official involved in developing methods of testing told us that the responsibility for progress toward standardization resides with the private sector, unless the federal government mandates degradable plastics and the standards to be met. At that point, according to this official, EPA would have to become more involved in activities relating to standards development.

National Institute of Standards and Technology

The Polymers Division within NIST, which has about 40 scientists with expertise in plastics, is planning to undertake one very small-scale project to test degradable plastics. The Group Leader, Chemical Performance and Standards, in this division has requested samples and is planning very limited testing. The tests will involve burying starch-based degradable plastics in soil and exposing them to selected strains of microorganisms.

According to the Deputy Director, Polymers Division, for NIST to expand its testing, one of three developments would have to occur: (1) the designation of a lead agency for degradable plastics and funding from that agency provided to NIST, (2) a budget initiative from within NIST, or (3) a congressional mandate. The Chief, Program Office, said that no determination has yet been made whether NIST would undertake an expanded degradable plastics program. She added that since NIST receives more than 40 percent of its funding from other agencies, it might be able to obtain funding elsewhere to support an effort in this area.

Food and Drug Administration

FDA has not approved any additives that are intended to increase the degradability of plastic food-packaging materials. However, the agency has recently been contacted by, and is working with, companies that are interested in food-packaging uses of degradable plastics. The burden of proof for the safety and functionality of a new product, as well as the analysis of environmental impact, rests with the manufacturer.

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[2] One of these studies, An Investigation of the Biodegradability of Packaging Plastics (Aug. 1972), concluded that the then-current packaging plastics were not biodegradable at practical rates.

To assess the safety of the indirect food additives that might impart degradability to plastic food-packaging materials, according to FDA, information is needed on (1) the effect of degradability on the shelf life of the package and (2) the potential migration of the additive from the package to the food. To assess the environmental impact of degradable plastics used for food-packaging material, information is needed on (1) whether a polymer is degradable and, if so, under what conditions and in what time frame; (2) the potential for increased environmental introduction of degradation products and additives from a degrading polymer; (3) the potential effects of small pieces of the degrading polymer in terrestrial and aquatic ecosystems; and (4) the impact of degradable polymers on recycling programs. The agency will determine the extent to which FDA resources are needed to develop testing methods for predicting the environmental impact of degrading plastics.

Private Sector Activities

Private sector activities are being planned primarily through ASTM. These activities have begun so recently, however, that their contribution to developing standards for degradable plastics is difficult to evaluate at present.

ASTM Activities

ASTM is a scientific and technical organization that develops standards on the characteristics and performance of materials and products. It describes itself as the world's largest source of voluntary consensus standards. It operates through 140 main technical committees designed to provide a balanced representation among producers, users, and consumers.

One of its committees, known as the D-20 Committee on the Permanence Properties of Plastics, is chiefly responsible for ASTM's recent efforts to develop standards for degradable plastics. The chairman of the D-20 Committee said that his committee has just begun to address the question of developing degradable plastics standards. The subject was broached for the first time at a committee meeting in March 1988. Members have agreed that they would like to develop a set of standards and methods for testing that would conform with ASTM's criteria. Two officials were appointed at the March meeting, one to develop definitions and one to develop standards and methods of testing.

The official concerned with definitions indicated that he is involved in defining five principal terms: biodegradability, photodegradability, environmental degradability, biodeterioration, and enhanced degradability. The main purpose for ASTM's work in defining these terms is to distinguish different manufacturers' products. The terms and definitions under development will be circulated among manufacturers and customers for comments and revisions.

The official concerned with standards and methods of testing indicated that the principal effort so far has consisted of a letter sent to about 40 companies and individuals inquiring whether they have or are aware of any standards relating to degradable plastics. He found no relevant standards but wanted to establish this fact as a starting point for further ASTM efforts to discuss and develop them.

With regard to methods of testing, ASTM's function is to provide a peer review process through which appropriate tests can be suggested, made known to other scientists, and evaluated for effectiveness. A plastics industry spokesperson believes that scientists need to identify the specific conditions (such as landfills and marine environments) to be replicated for degradable plastics testing; he would then like to see perhaps a half-dozen methods formulated and subjected to ASTM review.

The chairman of the D-20 Committee said that prior ASTM work on the permanence properties of plastics is relevant to degradable plastics. The committee's extensive experience with outdoor weathering of plastics, for example, is considered relevant, as is its work on the resistance of plastics to microorganisms. The D-20 Committee has developed and published three standard practices for performing experiments on the resistance of plastics to fungi, bacteria, and algae.

A scientist involved in developing and manufacturing degradable plastics expressed some concerns about these earlier ASTM procedures for exposing plastics to fungi and bacteria. He believes that the procedures need to be reassessed because of advances in the knowledge of biodegradation during the 15 years since the publication of these ASTM procedures. In expressing his concern that ASTM procedures may not accurately reflect the degradability of the plastic being tested, he stated:

> "A major end result of the differences between ASTM test conditions and environmental circumstances is that materials that are apparently not degradable by ASTM procedures may actually be degradable, and on the contrary, materials that support limited growth of microbes in the laboratory may not be fully degradable when placed in the environment."

In spite of ASTM's efforts to develop uniform definitions and methods of testing and its prior activities that may be relevant to degradable plastics, industry officials and scientists have expressed uncertainty about ASTM's future role in developing degradable plastics standards. They stated that ASTM reflects the views of its member companies and that many of these companies are doubtful about or opposed to degradable plastics. As a result, they question the degree of ASTM's commitment and its rate of progress in developing standards. One official associated with a company developing degradable plastics stated that ASTM may lack sufficient incentive to address the technical uncertainties and formulate standards. Estimates of time frames for ASTM's standards development range from 2 to 5 or more years, depending on the standards to be developed and the resources committed to the effort.

Other Private Sector Activities

In addition to ASTM's activities, at least one trade association is involved in testing degradable plastics. The Missouri Corn Growers Association has arranged for the University of Missouri to conduct tests intended to provide a more rigorous definition of degradability and to determine what by-products are leached from the plastics as they degrade in compost piles. Results of soil burial tests are expected in early 1989. The leaching assessment will conform with the EPA's Priority Pollutant Test, a procedure that screens for the presence of 132 different chemicals and heavy metals.

Appendix III

Federally Funded Research Related to Degradable Plastics

Four federal agencies are conducting or supporting basic or applied research directly related to degradable plastics. Scientists associated with the R&D projects recognize the need to test and develop standards for degradable plastics. Two other agencies with relevant expertise are funding no direct R&D projects, although they are conducting technical studies.

Federal R&D for Product Development

USDA, DOD, DOE, and NSF are supporting 12 R&D projects directly related to degradable plastics, at a total funding level of $1.7 million in fiscal year 1988. Expenditures for each agency are shown in table III.1.

Table III.1: Degradable Plastics R&D, by Agency, FY 1988

Agency	Number of projects	FY 1988 funding	Share of total (percent)
USDA	4	$941,000	55
DOD	4	575,000	33
DOE	3	150,000	9
NSF	1	63,000	3
Total	**12**	**$1,729,000**	**100**

The types of degradable plastics being investigated are derived from three different sources: starch, wood, and certain microorganisms (including bacteria and fungi) that are capable of directly producing polymers. Nearly two-thirds of the federal R&D spending is for cornstarch-based plastics, with microorganism-derived plastics accounting for slightly more than one-fourth of the total.

The 12 projects span the spectrum from very basic research, with a wide range of potential applications, to applied R&D intended for specific uses. Particular forms of degradable plastics being studied include films (for use as agricultural mulch, trash bags, and similar products) and molded products (such as containers and packaging for food). Films account for about 42 percent and molded products for about 20 percent of federal R&D; the remaining 38 percent consists of projects in which the forms are not separately identified.

Scientists conducting federally funded R&D recognize the technical uncertainties associated with degradable plastics and the need for standardization. As a result, a few have already incorporated testing as a basic part of their R&D; others are planning to conduct more extensive testing within the next year. USDA is planning to test its starch-based materials; DOD projects have included a limited amount of testing of the bacteria-produced plastic and a starch-based trash bag; one DOE project (which is also receiving funding from NSF) is planning extensive testing. This testing may help to evaluate product performance but does not entirely meet the testing needs for degradable plastics standards.

Two agencies, Commerce and EPA, are supporting no direct R&D, but they are conducting technical studies of degradable plastics. Commerce is funding two projects for about $160,000. EPA began a study in early 1988, and an OTA study is also underway.

The following section briefly summarizes the R&D projects currently being conducted or supported by federal agencies. It also describes the testing that is being conducted or planned. A compendium at the end of this appendix provides further details on each individual project.

Department of Agriculture

USDA accounts for about 55 percent of federal funding for degradable plastics R&D. Its research emphasizes the use of cornstarch. The focal point for USDA's activities is the Northern Regional Research Center (NRRC) in Peoria, Illinois. Two NRRC projects account for slightly more than $900,000 of USDA's expenditures. One project is directed toward degradable plastic films and is funded at $552,203 for fiscal year 1988. A new project, begun in February 1988, expands on NRRC's research in degradable plastic films by moving into molded products such as plastic cups and seedling pots; it is funded at $350,000 for fiscal year 1988. The remaining $40,000 is being used to support two research projects at the Universities of Illinois and New Hampshire, which are exploring the degradation rates of agricultural mulching films.

NRRC requested funding in June 1988 for a project that would develop methods of testing degradable plastics and subject their new products to these tests. The Project Manager plans to bring together specialists in microbiology, biochemistry, and polymer chemistry to devise more effective testing that simulates conditions in landfills. The tests would compare the degradability of different NRRC formulations and determine their relative lifetimes in municipal solid waste. The Project Manager would like to develop tests that can yield reliable results in a matter of days rather than months. The proposed project would be funded at about $150,000 per year and would be completed in September 1990.

A private firm, Agritech of Ceutopolis, Illinois, is working closely with NRRC. Agritech is primarily an R&D company that is just beginning to market degradable plastic products. The company received the rights to the exclusive use of three USDA patents from NRRC. The patents all relate to NRRC-developed products for degradable plastic films employed as agricultural mulch. Agritech has improved the products and is applying for patents of its own. To date, its work has been mostly with degradable plastic films, but it will assist the Center in its new research involving degradable molded plastics.

Department of Defense

DOD is funding four projects, three by the Navy and one by the Army, that together account for one-third of all federal R&D on degradable plastics. One Navy project is focused on the use of cornstarch; the other three projects involve the production of degradable plastics by means of microorganisms. The Navy project on cornstarch-based plastic, sponsored by the David Taylor Research Center of Annapolis, Maryland, is aimed at developing a biodegradable plastic trash bag for use at sea. It is being funded at $126,000, including $61,000 to support in-house activities (1 staff-year) and a $65,000 subcontract let to the Research Triangle Institute of North Carolina for R&D activities. Samples of various products are being exposed to ocean conditions. One basic concern is the size of the remaining plastic particles after degradation has occurred.

Two additional Navy projects, funded through grants by the Office of Naval Research, involve very basic research on bacteria producing a degradable plastic. The Navy awarded the University of Massachusetts $215,000 and the Massachusetts Institute of Technology $168,000 for fiscal year 1988. Written justifications for the awards include references to potential applications in degradable plastic products, but the Navy's program manager indicated that practical applications are probably several years away. Scientists at the University of Massachusetts have begun to test a plastic in low-salt environments but have not yet subjected it to a high-salt environment that would simulate marine conditions. The scientist at the Massachusetts Institute of Technology has not yet started testing but expects to begin by the end of 1988. Tests will involve burying samples in soil and exposing them to salt water.

An Army project, conducted at its Research Development and Engineering Center in Natick, Massachusetts, is also concerned with bacteria capable of producing a degradable plastic; its research is further exploring the use of fungi in this regard. The plastic is being converted into both films and fibers, which in turn can be processed for various applications, including food packaging. Funding is set at $66,000 for fiscal year 1988. The principal investigator said that testing is considered an integral part of the R&D. He has buried samples in a specified soil mixture with precise temperature and humidity controls. Samples have been taken at regular intervals to evaluate their loss of tensile strength. He has found that some of the materials degrade very quickly and some very slowly. He has also begun to identify the factors controlling the rates of degradation. He believes that with more experimentation he will be able to manipulate the material well enough to control the rate of degradation to a considerable extent. He is also planning to extend the testing from soil to different environments, including the marine environment.

Department of Energy

DOE's Energy Conservation and Utilization Technology Division has provided $150,000 to the Solar Energy Research Institute in Golden, Colorado, for R&D primarily involving wood. The Institute is seeking to develop innovative, inexpensive, lightweight materials to replace petroleum- and natural gas-derived plastics. A small in-house research effort at the Institute is combined with the efforts of researchers at local universities and three subcontractors. The three subcontractors are modifying wood fibers to produce plastics; one researcher is also investigating starch-based plastics. The projects are being conducted at the University of Wisconsin, Virginia Polytechnic Institute, and Purdue University. (As noted below, the scientist at Purdue is also receiving funding from NSF for related research.)

The Director of the Solar Energy Research Institute's Biobased Materials Program recognizes the need for testing to evaluate the rates of degradation and the safety of end products. The principal investigator for one of the three projects being managed by the Institute is planning a series of tests; the other two projects need to conduct further work with product development before preparations for testing are made. Specifically, the principal investigator of the project at Purdue is planning an extensive series of tests to evaluate the biodegradability of the plastics being developed. The tests will be performed with aerobic and anaerobic microorganisms[1] in environments with and without nutrients (water, sugar, and other normal nutrients for the microorganisms) and in different media (landfill or compost, garden soil, sewage sludge, sea water, and pure culture). Tests in a pure culture have the advantage of being easily quantifiable, meaning that results can be reproduced under completely controlled conditions. Tests will include several types of control samples as well as samples containing various percentages of starch combined with petroleum-based polymers. Several technical methods will be used to evaluate the results.

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[1] Aerobic and anaerobic microorganisms exist, respectively, with and without oxygen

National Science Foundation

NSF is funding one project directly related to degradable plastics. In the Biochemical and Biomass Engineering Division, a grant for $63,000 was awarded to Purdue University for R&D involving grafts of starch and wood with petroleum-based plastics. In NSF's Metallurgy, Polymers, and Ceramics Division, the Director for the Polymers Program reported no current projects related to the subject. He explained that NSF is oriented toward basic rather than applied research and regards degradable plastics as fitting into the latter category. He believes that enhancing the durability of plastics (as substitutes for ceramics and metals) is a better use of research funding. He added that his group has received virtually no proposals focusing on degradable plastics.

Technical Studies and Agency Coordination

In addition to the direct R&D work supported by federal agencies, several technical studies on issues related to degradable plastics have been completed or are underway. These have been undertaken by the Department of Commerce, EPA, and OTA.

Department of Commerce

No R&D related to degradable plastics is being funded in Commerce's fiscal year 1988 budget. Commerce, however, has provided about $160,000 for two technical studies related to degradable plastics. The National Oceanographic and Atmospheric Administration (NOAA), at the request of 30 Senators, provided about $100,000 to support an Interagency Task Force on Persistent Marine Debris. The task force, composed of 11 agencies,[2] has prepared a report assessing the problem of plastics at sea and ways of mitigating the problem. The report, which was submitted to the White House Domestic Policy Council in May 1988, contains two recommendations pertaining to degradable plastics R&D. The first proposes that NIST work with ASTM and other industry associations to develop standards and criteria for what constitutes "biodegradable" and "photodegradable." The second proposes that EPA, FDA, and NOAA work with plastics manufacturers to examine the reaction of degradable plastics in the environment, including potential environmental effects as the plastic degrades.

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[2] Participants in the interagency task force included USDA, DOD, EPA, Commerce, Interior, State, Transportation, Health and Human Services, the Council on Environmental Quality, the Office of Management and Budget, and the Marine Mammal Commission.

In addition to the Interagency Task Force, NOAA is funding a project through its Marine Entanglement Research Program within the National Marine Fisheries Service. The project is a review of current degradable plastics technologies and their applicability to plastics debris in the marine environment. A $60,000 contract has been let to the Research Triangle Institute in North Carolina to conduct the review. (NOAA and the Navy are coordinating their respective contracts with the Institute.) The contract calls for a literature analysis, evaluation of existing technologies, and an economic assessment of degradable plastics. It will also identify, if appropriate, further R&D that might be warranted, but it does not provide for original R&D by the contractor.

Environmental Protection Agency

At present, EPA is supporting no direct R&D related to degradable plastics at its laboratories. As mandated by the Marine Plastics Pollution Research and Control Act of 1987 (P.L. 100-220, sections 2001-2305), however, the agency is studying methods to reduce plastics pollution. As part of its study, EPA is required to investigate the feasibility of making articles from degradable plastics.

Specifically, EPA is required to take into account (1) the risk to human health and the environment that may be presented by fragments of degradable plastic articles and the properties of the end products of degradation, (2) the efficiency and variability of degradation due to different environmental and biological conditions, and (3) the cost and benefits of using degradable articles.

EPA has selected a contractor to carry out the portion of the study relating to degradable plastics. The contractor plans to review the relevant technical literature and monitor ASTM's efforts to develop definitions and methods of testing for degradable plastics. The reporting deadline for the study is June 1989.

Office of Technology Assessment

OTA began a study of municipal solid wastes in late 1987 and is due to report to Congress in March 1989. The study is focusing on the federal role in municipal solid waste management, including opportunities for reduction and recycling and for making incineration and landfilling safer. It covers all of the major materials in the waste stream (such as plastics, paper, glass, metal, rubber, and yard waste). OTA is analyzing the environmental risks and costs associated with municipal waste management technologies (including recycling), institutional barriers, and incentives.

Specifically concerning plastics, the report will describe what types and amounts are entering the waste stream and the current status of plastics recycling and degradable plastics. OTA will examine the technical, market, and institutional factors that may influence the use of these emerging technologies. Available information on the impact of degradable plastics on other disposal options, including landfills, incineration, and recycling will be discussed.

Compendium of Federal R&D Projects and Studies

Department of Agriculture

Project Title: Property Enhancement of Cereal Starch for Agricultural Use

Manager: Dr. W. Doane, Plant Polymer Research, Northern Regional Research Center, Peoria, IL

Funding: FY 1987: $544,971; FY 1988: $552,203

Timing: Started October 1985; expected completion, September 1989

Description: Increase the compatibility of starch with synthetic polymers to provide composites with properties acceptable for use as semipermeable membranes, biodegradable agricultural mulch, and other biodegradable plastics.

Project Title: Cornstarch-Based Biodegradable Molded Plastics

Manager: Dr. W. Doane, Plant Polymer Research, Northern Regional Research Center, Peoria, IL

Funding: FY 1988: $350,000

Timing: Started February 1988; expected completion, February 1991

Description: Develop process for injection-molded products. The project expands upon the Center's research in degradable plastic films by moving into molded products such as plastic cups and seedling pots.

Project Title: Micro-Environmental Modifications to Enhance Economic Yield and Quality of Vegetable Crops	Manager: Dr. J. Gerber, Dept. of Horticulture, University of Illinois, Urbana, IL Funding: FY 1988: $8,000 Timing: Started October 1986; expected completion, September 1989 Description: Field-test an already developed degradable plastic and adapt the product to Illinois; specifically, determine the effect of environmental parameters, agricultural chemicals, and plant canopy development on the use and efficacy of biodegradable and photodegradable mulch materials.
Project Title: Environmental Modification for Intensive Crop Production in Northern States	Manager: Dr. O.S. Wells, Dept. of Plant Science, University of New Hampshire, Durham, NH Funding: FY 1988: $30,585 (for degradable plastics research and other activities) Timing: Started October 1987; expected completion, September 1992 Description: Develop a containerized growing system for early production of tomatoes and peppers; monitor photodegradable plastic to determine rate of degradation and amount of labor saved by elimination of need for its removal.

Department of Defense

Project Title: Biopolymer Applications for Military Materials	Manager: Dr. David Kaplan, Army Natick Research, Development, and Engineering Center, Natick, MA Funding: FY 1987: $75,000; FY 1988: $66,000 Timing: Started March 1986; expected completion, September 1990 Description: Research is focused on bacteria and fungi capable of producing a plastic that is easily degradable and multifunctional. The product itself is being converted into both films and fibers, which in turn can be processed for various applications, including food packaging.

Project Title: Polymeric Hydroxybutyric Acid From Photosynthetic Bacteria

Managers: Dr. Robert Lenz, Polymers Science and Engineering Dept., and Dr. Clinton Fuller, Dept. of Biochemistry, University of Massachusetts, Amherst, MA

Funding: FY 1987: $260,000; FY 1988: $215,000

Timing: Started November 1986; expected completion, February 1990

Description: Characterize biosynthetic pathways for bacterial production of poly(beta)hydroxybutyric acid; determine possibilities for biosynthesis of related polymers and conditions for producing polymers of different molecular weight distributions. Justification for research includes potential applications in degradable plastic products.

Project Title: Strategies for Biopolymer Engineering of Polyhydroxybutyric-Like Materials

Manager: Dr. Anthony Sinskey, Dept. of Biology, The Massachusetts Institute of Technology, Cambridge, MA

Funding: FY 1987: $79,000; FY 1988: $168,000

Timing: Started March 1987; expected completion, March 1990

Description: Determine molecular genetics and enzymology of microbial production of polyhydroxybutyrate in order to control the chain length and composition of this biopolymer; characterize the physical and rheological properties of new biopolymer produced by modification in the biosynthetic pathway. Justification for research includes potential applications in degradable plastic products.

Project Title: Enhanced Degradable Plastics for Marine Waste Disposal

Manager: Dr. Todd Olson, David Taylor Research Center, Dept. of the Navy, Annapolis, MD

Funding: FY 1987: $35,000; FY 1988: $126,000

Timing: Started December 1987; expected completion, September 1991

Description: Develop a cornstarch-based, biodegradable plastic trash bag for use at sea. About $61,000 is being spent in-house to cover salary, travel, and administrative costs for 1 staff-year. A $65,000 contract has been let to Dr. Anthony Andrady (Research Triangle Institute, NC) to conduct the research.

Department of Energy

Project Title: Biobased Materials

Manager: Dr. Helena Chum, Chemical Conversion Research Branch, Solar Energy Research Institute, Golden, CO

Funding: FY 1987: $50,000; FY 1988: $150,000. Funding provided by DOE's Energy Conversion and Utilization Technologies.

Timing: Started August 1986; expected completion, not yet determined

Description: A small in-house research effort funded at about $50,000 is combined with the efforts of researchers at local universities and three subcontractors. The in-house effort aims at developing innovative, inexpensive, lightweight materials to replace totally or partially petroleum- and natural gas-derived commodity plastics. THE THREE SUBCONTRACTS ARE LISTED BELOW.

Project Title: Starch- and Lignin-Based Plastics

Manager: Dr. R. Narayan, Laboratory of Renewable Resources Engineering, Purdue University, West Lafayette, IN

Funding: FY 1988: $30,000

Timing: Started January 1988; expected completion, 3 to 4 years

Description: Synthesize grafts of starch and lignins with polystyrene and other vinyl polymers.

Project Title: Cellulose Derivatives From Steam-Exploded Hardwoods for Structural Materials

Manager: Dr. Wolfgang Glasser, Virginia Polytechnic Institute and State University, Blacksburg, VA

Funding: FY 1988: $34,550

Timing: Started January 1988; expected completion, 3 to 4 years

Description: Derive plastic materials from specially prepared wood fibers. The project aims to decrease the cost of these biomass-derived plastics.

Project Title: Plastic Wood	Managers: Dr. Ray Young and Dr. R. Rowell, Dept. of Forestry, University of Wisconsin, Madison, WI Funding: FY 1988: $31,065 Timing: Started January 1988; expected completion, 3 to 4 years Description: Investigate moldable wood products from chemically modified wood fibers by using innovative technology.

National Science Foundation

Project Title: New Synthetic Routes to Cellulosic Graft Copolymers	Manager: Dr. R. Narayan, Laboratory of Renewable Resources Engineering, Purdue University, West Lafayette, IN Funding: FY 1988: $63,000 Timing: Started May 1987; expected completion, October 1988 Description: Synthesize grafts of lignins with polystyrene and other vinyl polymers.

Department of Commerce

Project Title: Interagency Task Force on Persistent Marine Debris	Manager: Dr. David Cottingham, Executive Secretary Funding: $100,000 (based on Executive Secretary's estimate) Timing: Started April 1987; completed April 1988 Description: The task force consisted of 11 agencies. Its report, entitled Report of the Interagency Task Force on Persistent Marine Debris, assesses the problem of plastics at sea and ways of mitigating it. The report was submitted to the White House Domestic Policy Council in May 1988.

Project Title: Marine Entanglement Research Program

Manager: Dr. James Coe, NOAA, National Marine Fisheries Service, Seattle, WA

Funding: FY 1988: $60,000

Timing: Started December 1987; expected completion, June 1988

Description: The project is a technical review of current degradable plastics technologies and their applicability to plastics debris in the marine environment. A contract has been let to Dr. Anthony Andrady (Research Triangle Institute, NC) to conduct the review.

Environmental Protection Agency

Project Title: A review mandated by the Marine Plastics Pollution Research and Control Act (P.L. 100-220, sections 2001-2305)

Managers: Dr. Susan Mooney, Office of Solid Waste, and Dr. David Redford, Office of Marine and Estuarine Protection

Funding: Unknown

Timing: Started spring 1988; expected completion, June 1989

Description: EPA is required to investigate the feasibility and desirability of making articles from degradable plastics; it is also required to investigate the safety of the end products resulting from degradation of the plastic. EPA has assembled a task force to conduct the review.

Office of Technology Assessment

Project Title: Municipal Solid Waste Management	Manager: Dr. Howard Levinson, Oceans and Environment Program Funding: Unknown Timing: Started November 1987; expected completion, April 1989 Description: Evaluation of how different technologies for reducing and managing municipal solid waste can be used in an environmentally safe and cost-effective long-term strategy.

Appendix IV

Major Contributors to This Report

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